Iron and Steel ENGINEER

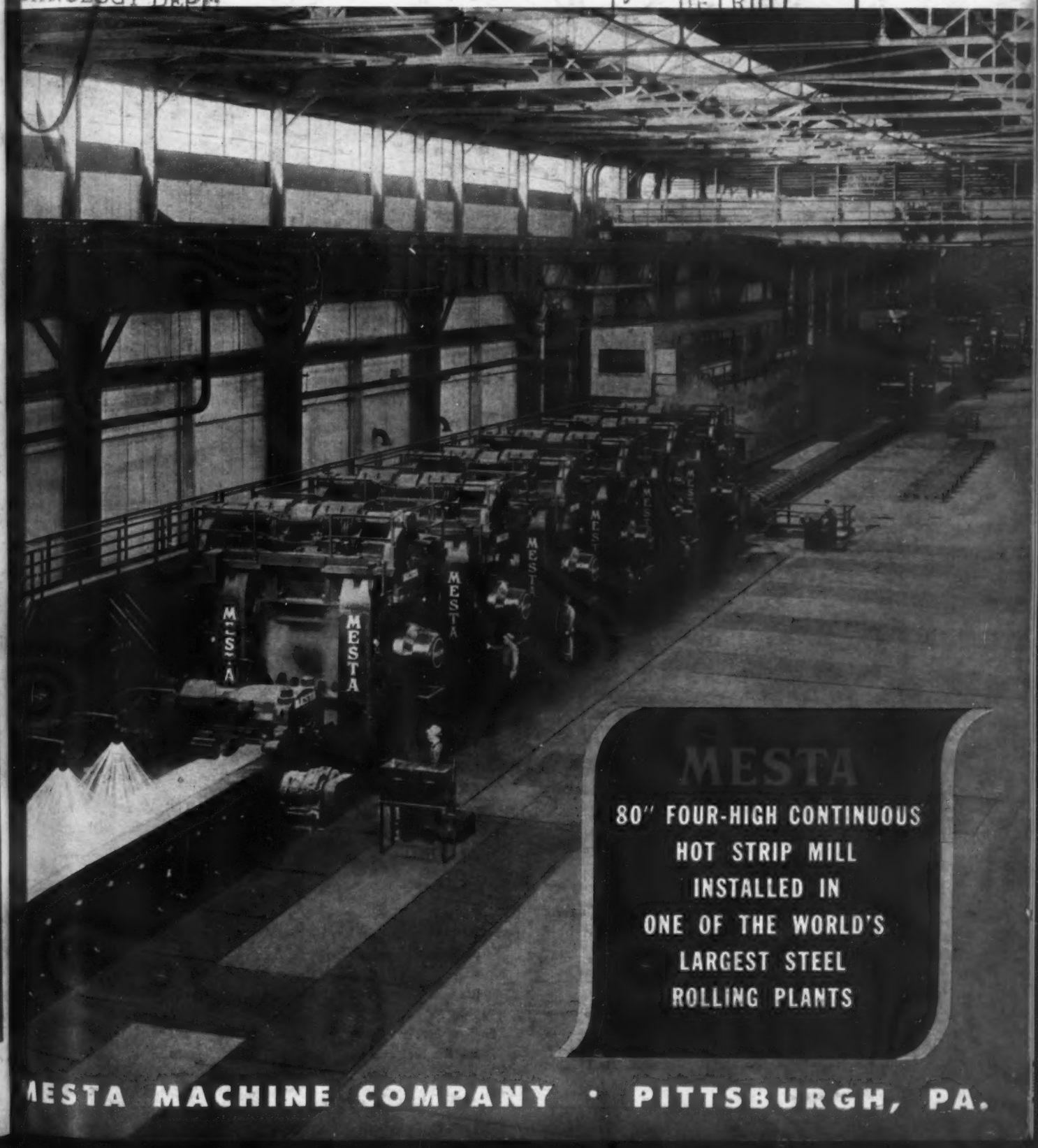
ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

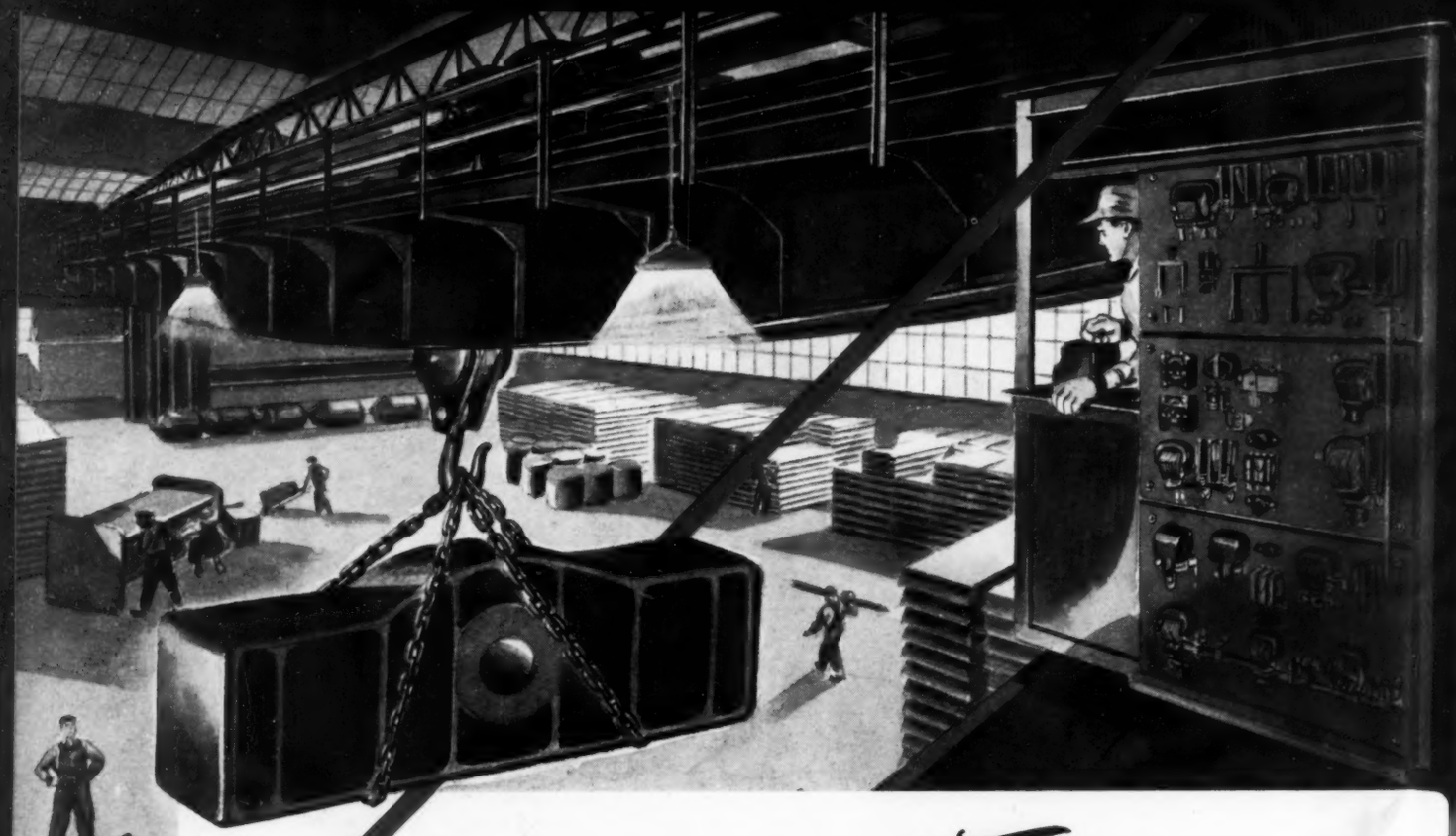
1010 EMPIRE BUILDING | August 1944 | PITTSBURGH, PA.

CHNOLOGY DEPT

SEP 5 - 1944

DETROIT





For the first Time

FIVE DEFINITE AND STABLE LOWERING SPEEDS OF CRANE HOISTS

on Alternating Current

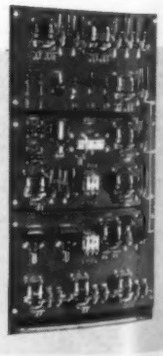
It is no longer necessary for crane users to turn to direct current when they want maximum crane hoist performance. It is no longer necessary to put up with costly, troublesome load lowering brakes on alternating current crane hoists. Cutler-Hammer Engineers have solved this problem . . . the problem of getting 5 stable selective speed points—both hoisting and lowering; full dynamic braking; accurate inching; timed acceleration in both directions and timed deceleration for spotting a load . . . *all on alternating current.*

This new Cutler-Hammer AC Crane Control can be used with any standard slip ring crane motor and is available in drum type manual and magnetic types. Specify this outstanding engineering development for your next crane. Write today for full information. CUTLER-HAMMER, Inc., 1269 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ont.

CUTLER-HAMMER
MOTOR CONTROL
C-H

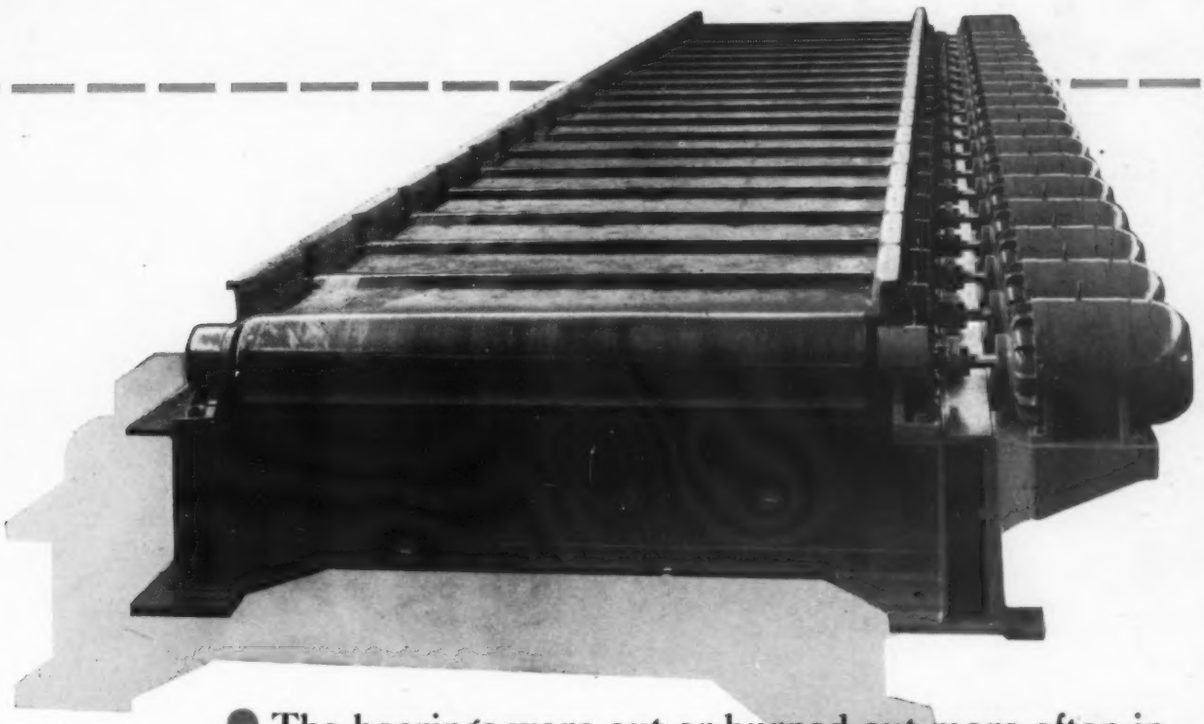
Control engineering ingenuity solved the long-standing problem of how to get crane performance on alternating current. This control panel of standard C-H units does the job with a standard AC motor.

Engineering Excellence finds its Greatest Reward in the Respect and Confidence of those it Serves

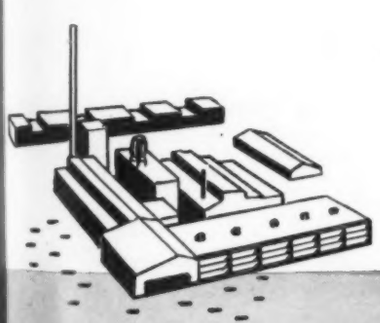


Remember YOUR OLD-STYLE MILL TABLES?

. . . . . And Look at the New Ones



Section of a recent mill table installation by Aetna-Standard, equipped with individual motor-driven rollers



● The bearings wore out or burned out more often in your old-style mill tables since anti-friction bearings still had to be developed. The ponderous gears never seemed to mesh just right, but better alloy steels and precision workmanship changed all that. And remember the grease monkeys? They disappeared when central lubricating came into prominence. Use of cast steel and structural steel resulted in a more serviceable and rugged construction. • Yes, the old mill tables did their bit, but it would be difficult to move today's tremendous tonnages without modern mill tables.

AETNA-STANDARD HAS INTRODUCED MANY FEATURES IN 33 YEARS OF BUILDING MILL TABLES

Designers, metallurgists, and engineers have all worked together at Aetna-Standard to improve the general status of mill tables. We have not been responsible for all of the changes outlined above, but many improvements and innovations did see the light of day in our shop. Today we manufacture all sizes and types of tables, including the following: Furnace Charging, complete with pusher; Furnace Delivery; Structural Tilting and Trailing; Bar Mill and Tube Mill Conveyor Tables.

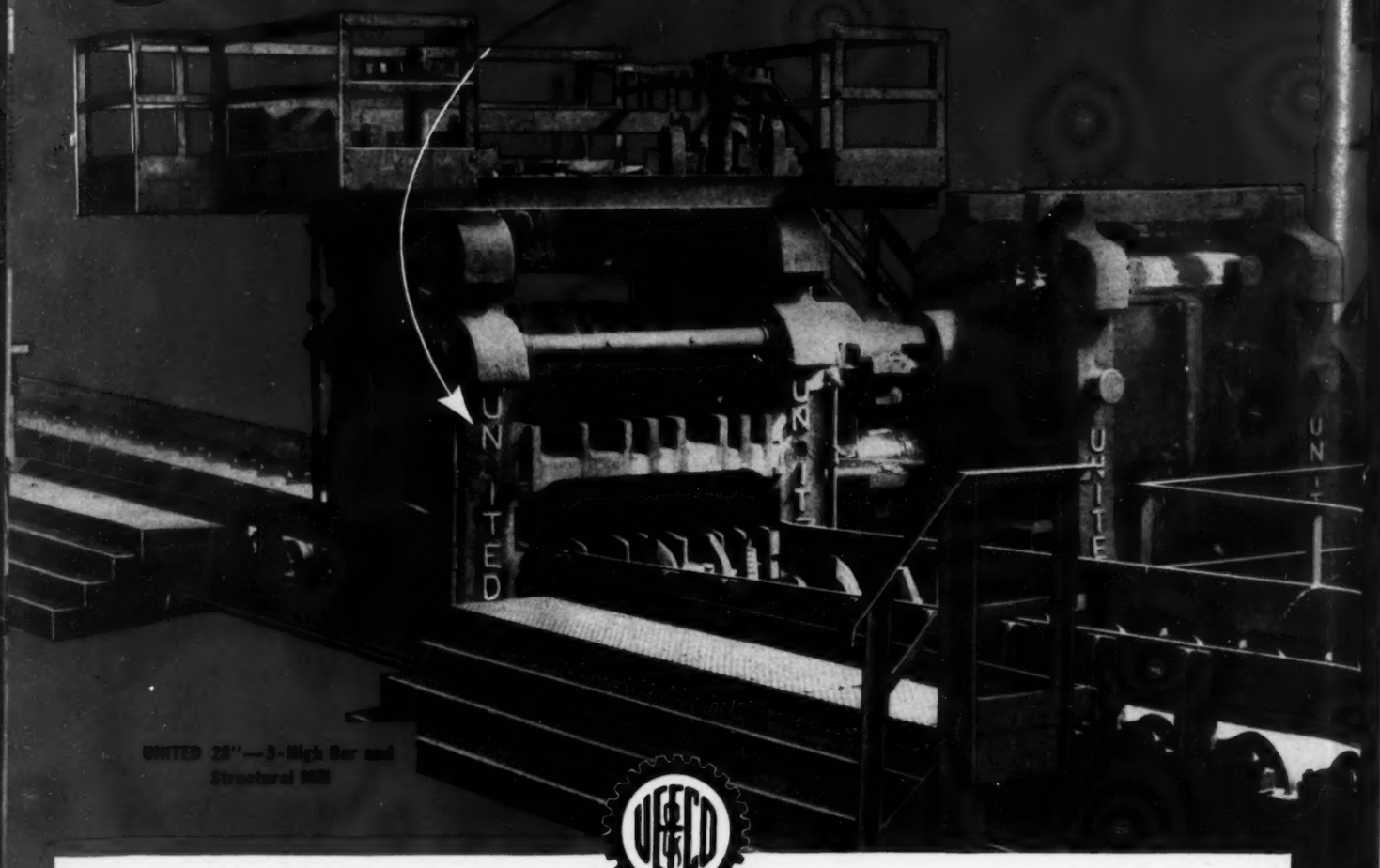
The **AETNA-STANDARD ENGINEERING COMPANY**
YOUNGSTOWN · OHIO · U.S.A.

ARMY ★ NAVY

ASSOCIATED COMPANIES: HEAD, WRIGHTSON & COMPANY, LIMITED, THORNABY-ON-TEES, ENGLAND • JOHN INGLIS COMPANY, LIMITED, TORONTO, ONTARIO, CANADA

★ DESIGNERS AND BUILDERS TO THE STEEL, NON-FERROUS AND CHEMICAL INDUSTRIES ★

UNITED Bar and Structural Mills



UNITED 28"—3-High Bar and Structural Mill

Designs of Recent, Modern Installations Available

To meet war requirements we greatly increased our Rolling Mill production facilities. Very soon we expect to be able to offer attractive deliveries on units duplicating existing designs of all types and all sizes of BAR AND STRUCTURAL MILLS, or modifications of them adapted to meet your specific requirements.

Recognized pre-eminence in technical research, and more than 40 years experience in the design, construction and installation of Rolling Mills and their auxiliary equipment for leading steel manufacturers throughout the world, is evidence of UNITED'S ability to serve you.

In planning for present or post-war expansions, you should consult with our engineering staff.

UNITED ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

Plants at PITTSBURGH, VANDERGRIFT, NEW CASTLE, YOUNGSTOWN, CANTON
Davy and United Engineering Company, Ltd., Sheffield, England
Dominion Engineering Works, Ltd., Montreal, P. Q. Canada

The World's Largest Designers and Makers of Rolls and Rolling Mill Equipment

IF YOU WANT TO WORK MAGNESIUM

ASK US

WE ARE EXPERTS IN EVERY FIELD OF HYDRAULIC MACHINERY FOR WORKING MAGNESIUM AND OTHER LIGHT METALS AND ALLOYS.

ANY IMAGINABLE SHAPE CAN BE EXTRUDED ON OUR HYDRAULIC PRESSES. QUICK CHANGE OF DIES GIVES WIDEST RANGE OF VARIATION.

HYDROPRESS · INC.

ENGINEERS CONTRACTORS

HYDRAULIC PRESSES · ROLLING MILLS
STRETCHERS · PUMPS · ACCUMULATORS

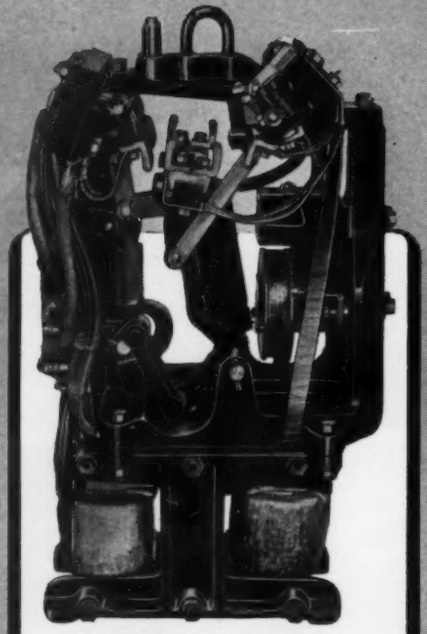
570 LEXINGTON AVENUE · NEW YORK · N. Y.

One of several pumping stations using many EC&M Starters, supplying water to a large northeastern war plant.

REDUCED VOLTAGE Motor Starters

SERVE OUTDOOR PUMPING STATION....

No Control Room Needed



COMPENSATOR MECHANISM

Single, quick-break, double-throw Contactor operated by a *single* magnet. Quick transfer from reduced voltage starting to full voltage running by a throw-over spring and a mechanical latch tripped by a current limit relay.

DAY in and day out, in the freezing winter, in the sizzling summer heat and the torrential rains—under all weather conditions—these EC&M Starters operate successfully.

They are simple, completely wired units, totally enclosed and oil-immersed in steel tanks.

Total oil-immersion of the compensator-mechanism not only permits interrupting the circuit under oil (recognized as an effective means for breaking alternating currents), but also provides continuous lubrication for all operating parts of the mechanism and protects them from dust, moisture and corrosion.

Wherever moisture, corrosion and dust must be combated, these EC&M Starters provide fool-proof, dependable operation. *Ask for Bulletin 1045-B.*

THE ELECTRIC CONTROLLER & MFG. CO.

2700 E. 79th ST. ★ CLEVELAND 4. OHIO

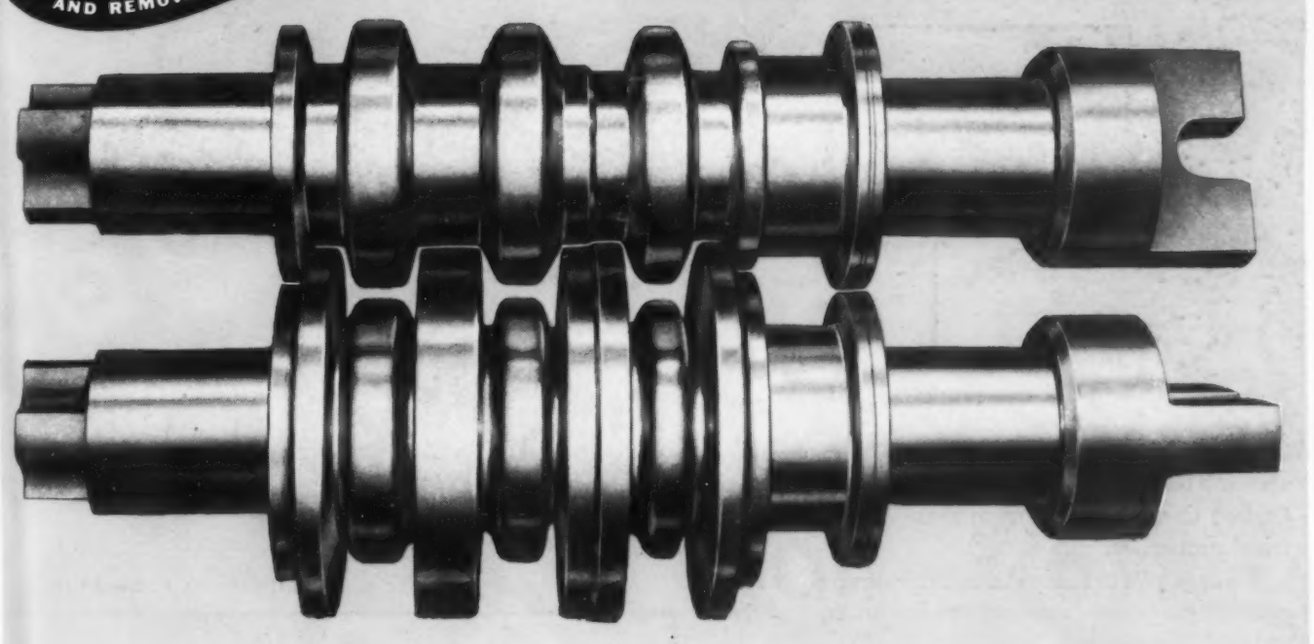
IN ROLLS

Craftsmanship Means Greater Tonnage
Longer Roll Life—Lower Roll Costs

Utmost manufacturing precision and attention to small details is as important in roll production as it is in the manufacture of a fine watch. The same careful attention must be given to every step in the manufacturing process—to produce rolls with longer life—at lower cost.

It is this craftsmanship in manufacture that gives Continental Blooming Mill Rolls their reputation for delivering greater tonnage—is the reason Continental Rolls can serve you better and why they are the choice of mill operators everywhere. Specify Continental Rolls for increased production.
Continental Foundry & Machine Company

BLOOMING MILL ROLLS
WITH BEAM BLANKS
AND REMOVABLE UNIVERSAL COUPLINGS



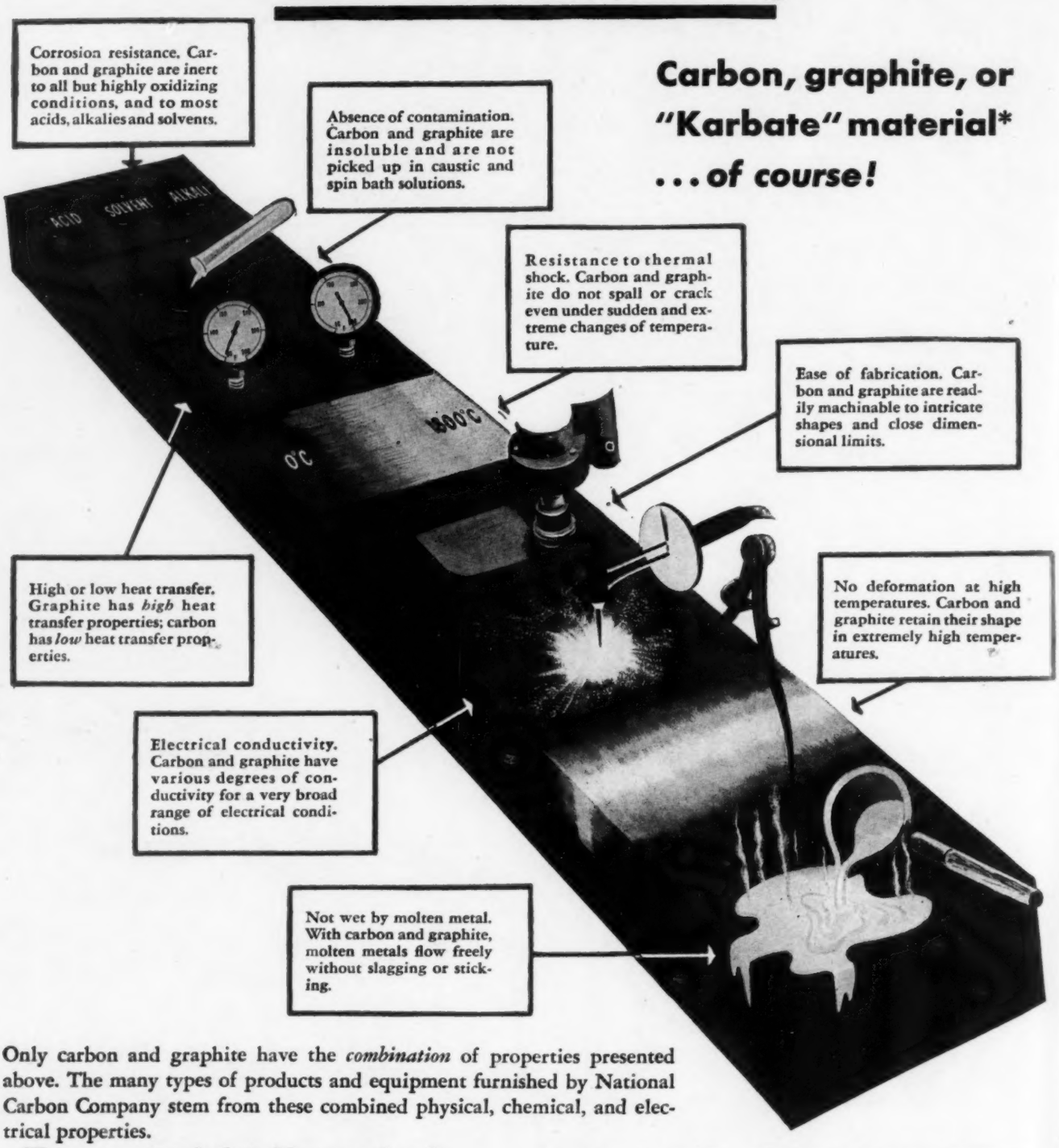
Continental Foundry & Machine Company

(FORMERLY CONTINENTAL ROLL & STEEL FOUNDRY COMPANY)

CHICAGO • PITTSBURGH

BAR OF *What?*

Carbon, graphite, or "Karbate" material* ...of course!



Corrosion resistance. Carbon and graphite are inert to all but highly oxidizing conditions, and to most acids, alkalies and solvents.

Absence of contamination. Carbon and graphite are insoluble and are not picked up in caustic and spin bath solutions.

Resistance to thermal shock. Carbon and graphite do not spall or crack even under sudden and extreme changes of temperature.

Ease of fabrication. Carbon and graphite are readily machinable to intricate shapes and close dimensional limits.

High or low heat transfer. Graphite has *high* heat transfer properties; carbon has *low* heat transfer properties.

No deformation at high temperatures. Carbon and graphite retain their shape in extremely high temperatures.

Electrical conductivity. Carbon and graphite have various degrees of conductivity for a very broad range of electrical conditions.

Not wet by molten metal. With carbon and graphite, molten metals flow freely without slagging or sticking.

Only carbon and graphite have the *combination* of properties presented above. The many types of products and equipment furnished by National Carbon Company stem from these combined physical, chemical, and electrical properties.

We urge you to study them. They not only make possible the present applications but are constantly suggesting new ones.

Many of these applications can further improve your manufacturing operations by decreasing interruptions, speeding up output, and cutting production and maintenance costs.

★ BUY UNITED STATES WAR BONDS ★

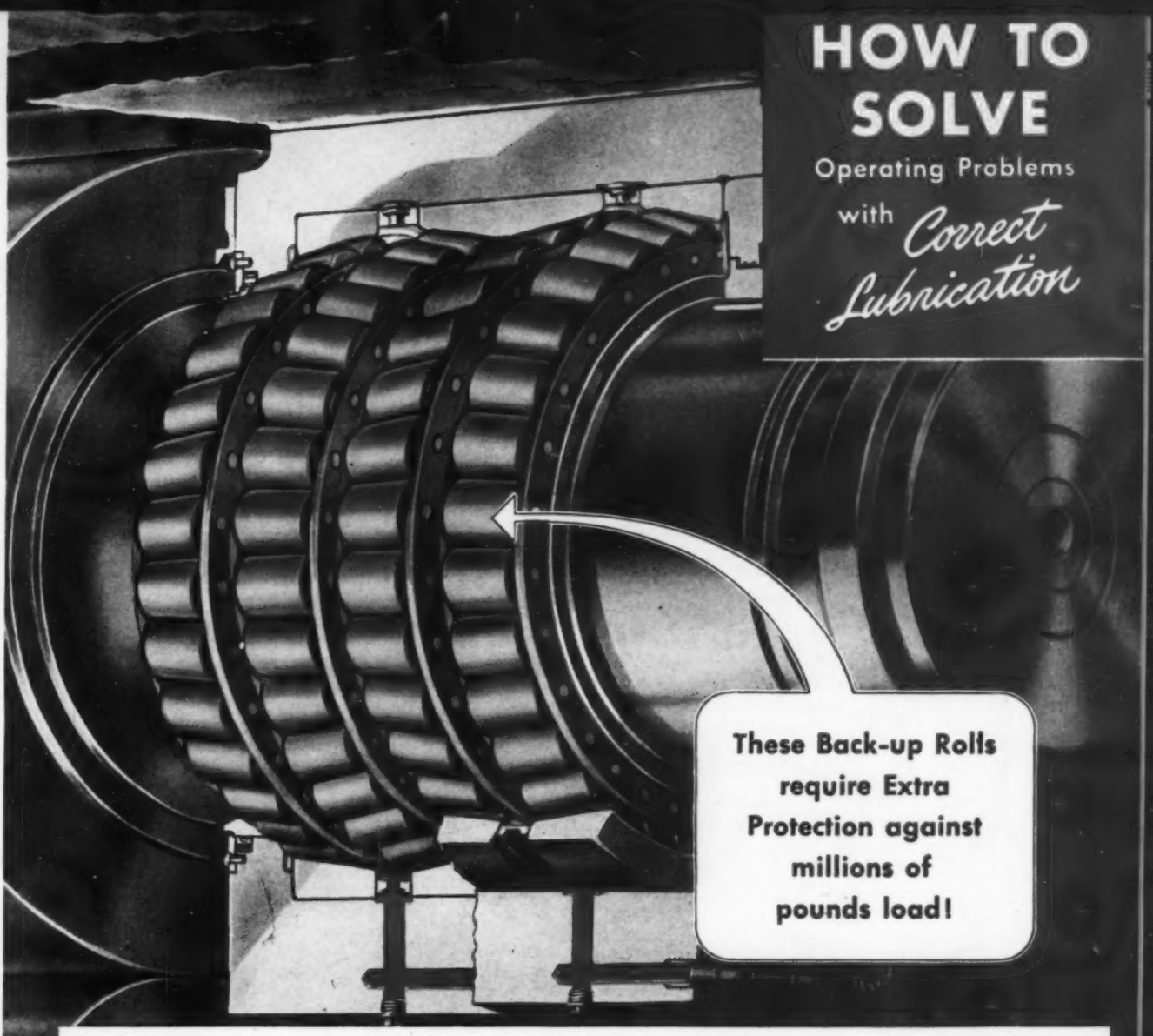
The word "Karbate" is a registered trade-mark of National Carbon Company, Inc.

*Carbon or graphite made impervious to seepage.

NATIONAL CARBON COMPANY, INC.
Unit of Union Carbide and Carbon Corporation
UCC
General Offices: 30 East 42nd Street, New York 17, N. Y.
Division Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

ONE OF A SERIES OF SUGGESTIONS TO AID PRO

ONE OF A SERIES OF SUGGESTIONS TO AID PRODUCTION



HOW TO SOLVE
Operating Problems with *Correct Lubrication*

These Back-up Rolls require Extra Protection against millions of pounds load!

New Grease Unequaled
UNDER HEAVY STEEL MILL LOADS!

ON heavy-duty back-up rolls, like those above, Gargoyle Grease Sovarex L is proving it provides dependable lubrication under heavier pressures than any other grease.

And this is just one important quality of this new patented lubricant. Specially developed for steel mill service, Sovarex L stands up under temperatures as high as 450° F.

It also resists the washing action of water on work and table rolls as well as back-up rolls.

In service in many mills, Gargoyle Grease Sovarex L is prolonging the life of costly bearings, saving maintenance time and costs and reducing leakage to cut lubrication expense. See your Socony-Vacuum representative for full details on this special grease.

GARGOYLE Lubricants

SOCONY-VACUUM OIL CO., INC., Standard Oil of N. Y. Div. • White Star Div. • Lubrite Div. • Chicago Div. • White Eagle Div. • Wadhams Div. • Magnolia Petroleum Company • General Petroleum Corporation of California.

CALL IN SOCONY-VACUUM

*Extreme

TIDE WATER LUBRICANIA

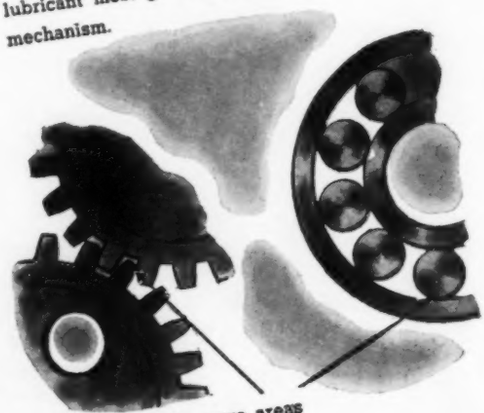
DEFINITION: Extreme Pressure Lubricants are mineral oils or greases compounded with certain additives, which give the lubricants the property of "greatly increased load-carrying ability." (The slight increase in load-carrying ability which occurs when fatty oils are added to mineral oils is not sufficient to justify such products being termed Extreme Pressure Lubricants.)

EXPLANATION: Mechanisms such as gears, anti-friction bearings operate with both a rolling and rubbing action. The areas of contact between the gear teeth, or in the case of the anti-friction bearings, between the rolls or balls and their races, are extremely small, hence unit pressures may become very great, often in the region of four or five hundred thousand pounds per square inch. Under these conditions of loading, and as rubbing velocities increase, mineral oils regardless of viscosity are unable to maintain an unbroken fluid film of oil between the relatively moving parts. The metals in contact each being made of steel are not in themselves good bearing surfaces. The result is that when metal to metal contact occurs, high local temperatures develop, resulting in incipient welding of the metal parts in contact. As motion continues, they tear apart resulting in scored surfaces on the gear teeth, rolls, balls or races.

By adding certain compounds to the oil (usually compounds containing sulphur, chlorine or phosphorus), an "Extreme Pressure Lubricant" is evolved. When sufficient local heat is developed by contact of the steel surfaces, the additive in the Extreme Pressure Lubricant decomposes. The active ingredient is liberated and immediately reacts with the steel surfaces at points of contact, forming a new and softer surface — viz., Iron Sulphide, Chloride or Phosphide as the case may be. These newly formed surfaces, being relatively soft act as excellent bearing surfaces in themselves and become self lubricating. They also act as an anti-flux and prevent any tendency towards incipient welding.

Provided the heat in these parts can be quickly removed so that the newly formed surfaces are not destroyed, and this is accomplished by the liquid lubricant surrounding them, excellent performance under Extreme Pressure operation is obtained.

NOTE: Extreme Pressure Lubricants do not perform as such between bearing surfaces other than steel on steel. For the lubrication of worm gear drives, where bronze on steel is utilized, the relatively soft and good bearing metal "bronze" operating against the harder "steel" provides an excellent condition of "solid lubrication". This only requires a lubricant that quickly removes heat and prevents softening of the bronze. A straight mineral oil or a mineral oil containing a small quantity of fatty oil is the lubricant most generally used in this type of mechanism.



Extreme Pressure areas

Gasoline Powers the Attack — Don't Waste A Drop

INDUSTRIAL TYCOL OILS

SCIENTIFICALLY ENGINEERED FOR EVERY INDUSTRIAL USE TYCOL

PRESSURE

* This is the 11th of a series of informative messages concerning the meaning and significance of commonly used tests and terms employed to describe the characteristics of lubricating oils.

DRUMS! DRUMS! DRUMS!
War needs make it extremely important that all empty drums be returned immediately.

Whatever your lubricating need – extreme pressure, high or low temperature, high speed, or any other service condition – there's a Tycol oil or grease exactly suited to your specific need.

Tide Water Engineers will recommend the Tycol lubricant that meets your particular requirements. Call or write your nearest Tide Water office.

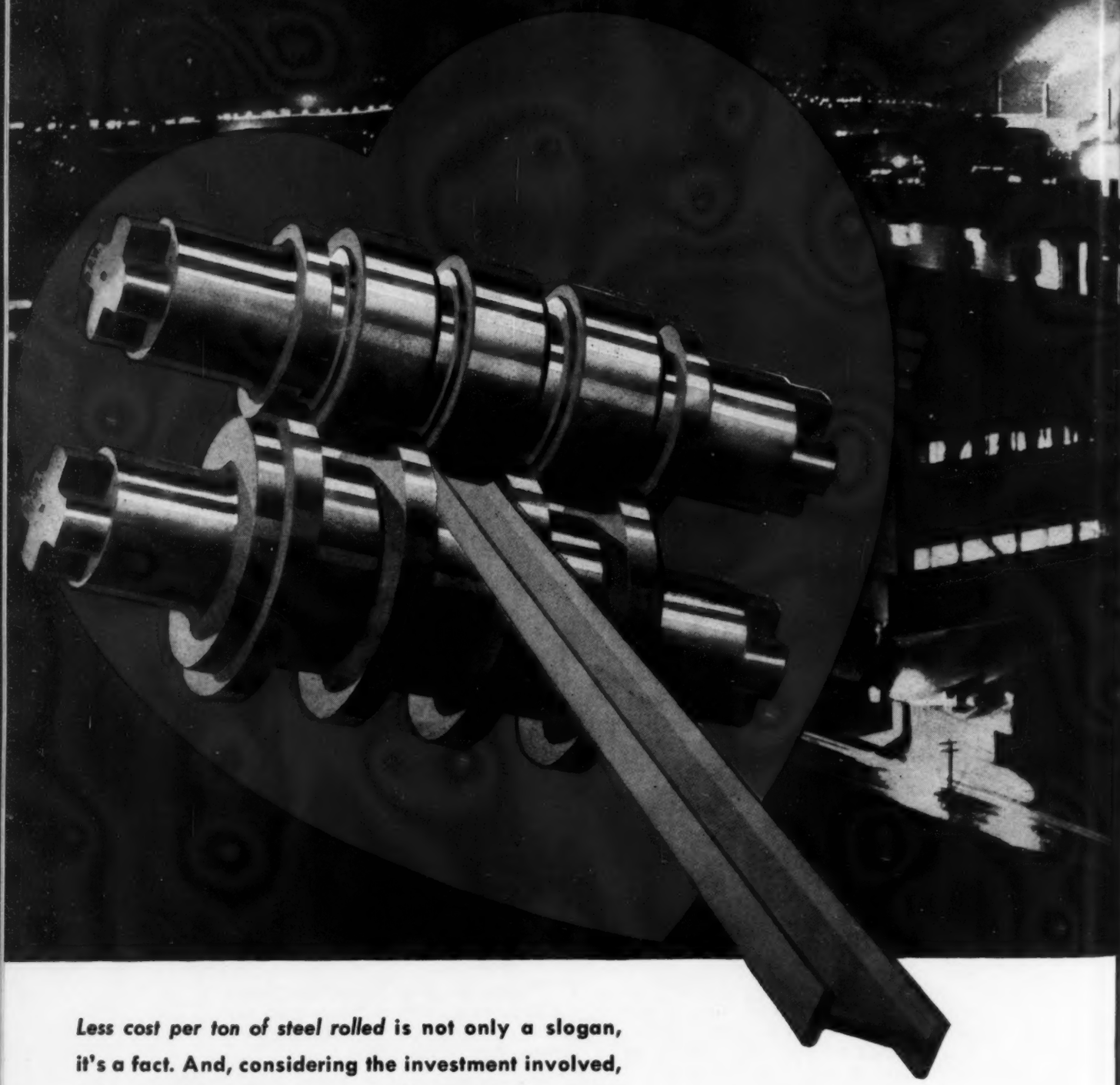
TIDE WATER ASSOCIATED OIL COMPANY

MAKERS OF THE FAMOUS VEEDOL MOTOR OIL • Eastern Division: 17 Battery Place, New York 4, N. Y.

Principal Branch Offices: Boston, Philadelphia, Pittsburgh, Charlotte, N. C.

INDUSTRIAL LUBRICANTS

THE *HEART* OF THE ROLLING MILL



Less cost per ton of steel rolled is not only a slogan, it's a fact. And, considering the investment involved, it is good business to specify Pittsburgh Rolls and get the utmost from the "heart" of your mills.

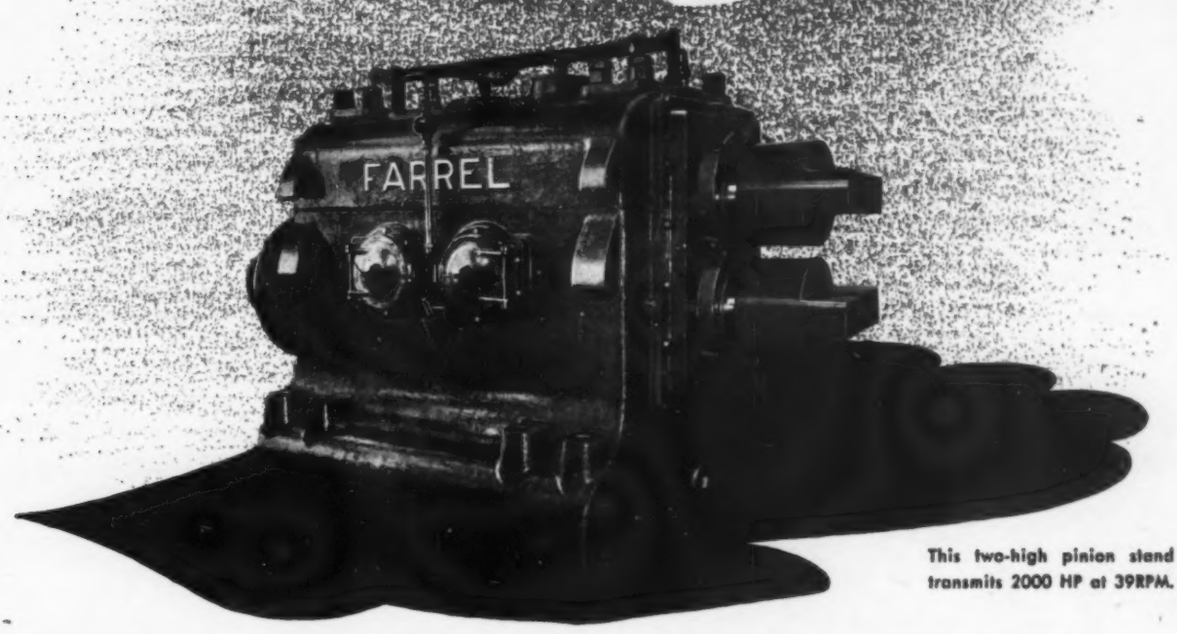
BUY U. S. WAR BONDS AND STAMPS

PITTSBURGH ROLLS

PITTSBURGH ROLLS DIVISION of BLAW-KNOX CO.—"Steel's Partner" • PITTSBURGH, PA.

HOW TO TELL A GOOD PINION STAND

when you meet one



This two-high pinion stand transmits 2000 HP at 39RPM.

A rolling mill pinion stand is a relatively simple piece of equipment—mechanically speaking. If it operates efficiently and quietly over a long period of years, it is doing all that can be expected of it. But how can you know that your new pinion stand will do these things?

Continuous tooth herringbone rolling mill pinions, precision generated by the Farrel-Sykes process.

Is the housing strong enough to bear the brunt of continued strain and stress encountered in actual service and yet maintain accurate alignment of the pinions? Are the bearings adequately proportioned for the job they have to do? Is the lubrication system simple in design, certain in operation and as nearly foolproof as it is possible to make it? If the pinion stand is designed and built by Farrel-Birmingham the answer is "yes" to all of these questions and it only remains to open the housing and examine the pinions themselves.

In a Farrel stand you will find that the pinions are the continuous tooth herringbone type, made by the famous Farrel-Sykes process of gear generation. The teeth forming the two helices meet in sharp apices, instead of being separated by a center groove, as is the case with some pinions.

This means extra strength and greater load-carrying capacity in smaller space. Then too, precision generation, interlacing of the teeth, gradual engagement and inclined line of pressure all contribute to smooth, quiet operation and maintenance of correct tooth action throughout the life of the pinions.

Further details of these *designed-for-the-job* pinion stands will be sent on request. No obligation, of course.

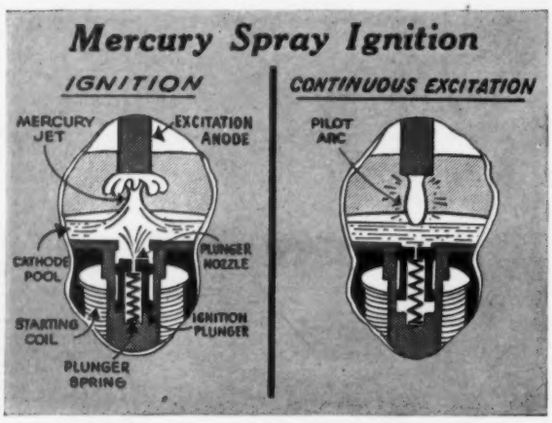
FARREL

FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.

Plants: Ansonia and Derby, Conn., Buffalo, N. Y.
Sales Offices: Ansonia, Buffalo, New York, Pittsburgh, Akron, Los Angeles

Farrel-Birmingham

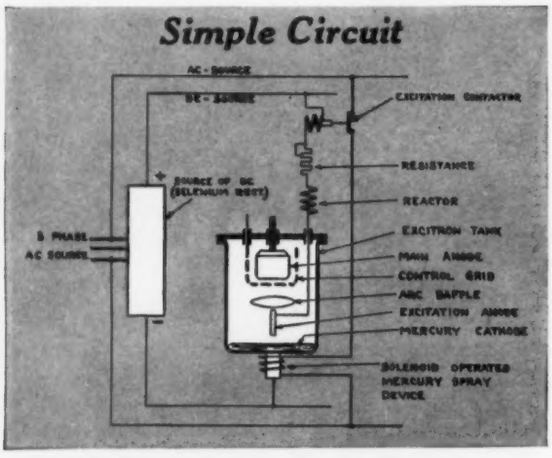
NO OTHER SINGLE ANODE RECTIFIER IS CONTINUOUSLY PRIMED!



☛ Allis-Chalmers' Excitron is the only mercury arc rectifier which gives you the advantages of "continuous excitation".

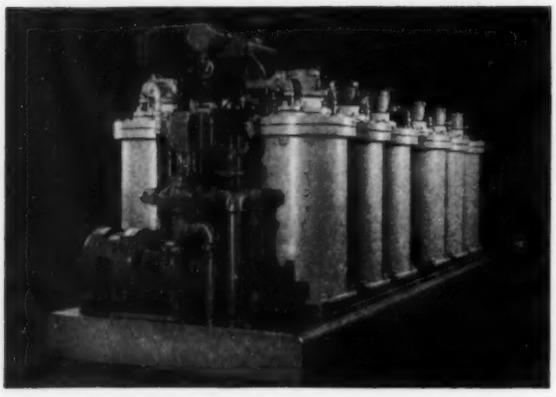
☛ That means with Excitron there are no ignition impulses to be synchronized with main anode voltage. Tubes don't require re-ignition at start of each positive half-cycle.

☛ Solenoid mercury-spray device creates small d-c pilot arc which keeps tube primed for firing while rectifier is in service.



☛ Excitron is the only rectifier with a simple excitation circuit. Elements of circuit are familiar, commonly used. No "tuning" is necessary to maintain proper wave shape. Once adjusted and tested at factory, no further adjustment is required in the field.

☛ Only Excitron takes direct current from a 3-phase source for excitation. Stability of excitation cannot be affected by average single phase dips in the a-c system voltage.



☛ In Excitron, each anode has its own vacuum vessel and mercury cathode. That means compact construction, short arc, small arc-drop, high operating efficiency.

☛ Allis-Chalmers engineers introduced mercury arc rectifiers to U. S. industry. Excitron is time-proven.

☛ Consider Excitron for all power conversion from 250 v. Allis-Chalmers, Milwaukee 1, Wis.

A 1718

ALLIS-CHALMERS EXCITRON MERCURY ARC RECTIFIERS

AIRCO GASES

... FOR PRODUCTION, MAINTENANCE AND RESEARCH

AIRCO gases, produced by modern scientific methods to the strictest standards of purity and uniformity, are supplied to industry through nation-wide Airco distributing points. These gases are available in volumes to meet every requirement... in standard commercial size cylinders and in trailers with capacities up to 40,000 cu. ft. Thus Airco gases are quickly delivered to shops and plants throughout the country in whatever size containers are most suitable for the customers' needs. In that way, individual requirements for 200, 20,000, or several million cubic feet, monthly, are met.

To assist manufacturers in using these Airco gases most effectively, Air Reduction provides "on-the-job" technical assistance through its Applied Engineering Field Service Department. For further information on Airco gases—as well as Airco's complete line of apparatus and supplies for every oxyacetylene flame application and arc welding need—call or write the nearest Airco office, or, if you prefer, communicate direct with the New York Office, Department IS

OXYGEN guaranteed 99.5% pure... assures maximum speed and economy in cutting, and greater efficiency in welding.

ACETYLENE proved by use and test to be the most economical fuel gas for oxyacetylene welding and other flame applications.

NITROGEN dry and inert, contains less than 0.3% oxygen. Also available at higher purity to meet specialized needs.

HYDROGEN produced electrolytically, contains less than 0.5% oxygen.

ARGON manufactured pure or mixed with nitrogen as specified by user.

HELIUM is available with a purity of approximately 98% and higher.

★ BUY UNITED STATES WAR BONDS ★

AIRCO WILSON

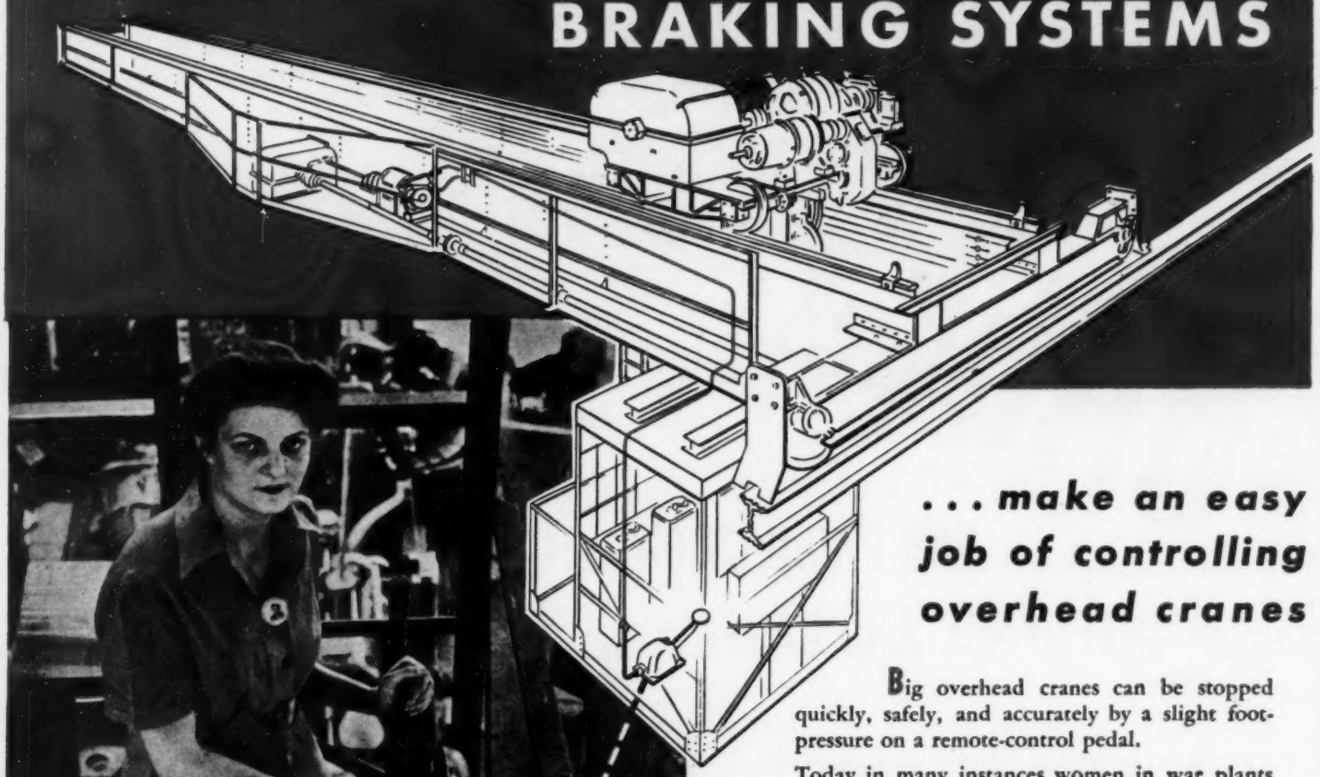
AIR REDUCTION

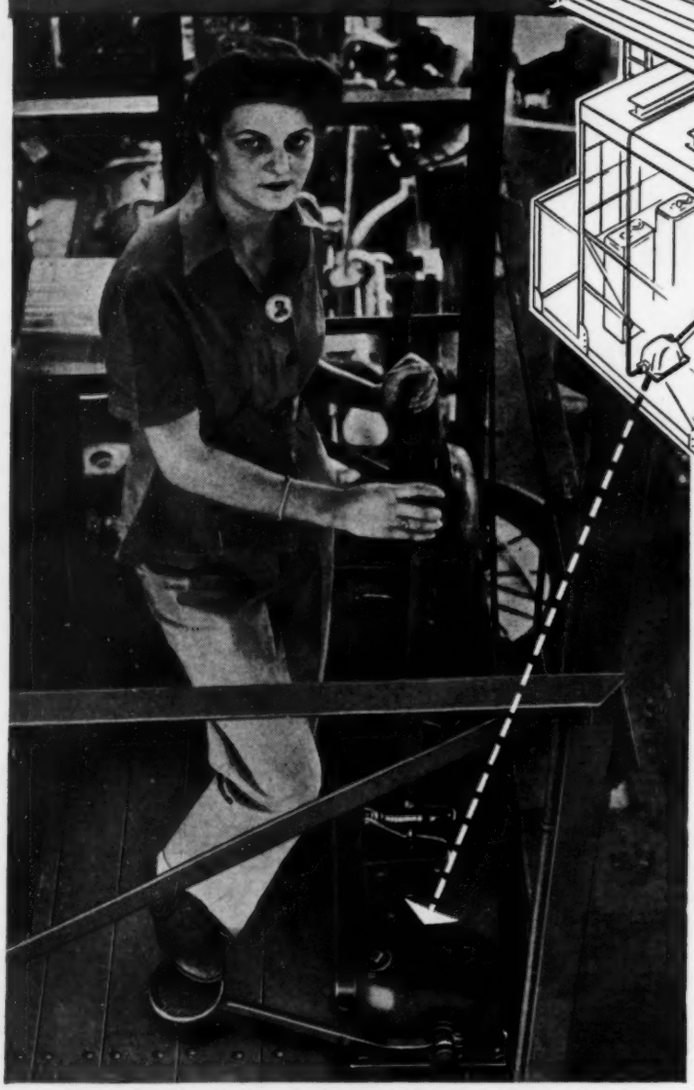
General Offices: 60 EAST 42nd STREET, NEW YORK 17, N. Y.

In Texas: MAGNOLIA AIRCO GAS PRODUCTS CO. • General Offices: HOUSTON 1, TEXAS

Offices in all Principal Cities

Wagner INDUSTRIAL HYDRAULIC BRAKING SYSTEMS





The above illustration is one of the twelve cranes operated by women at a large midwest war-production plant.

BACK THE ATTACK — BUY U. S. WAR BONDS

. . . make an easy job of controlling overhead cranes

Big overhead cranes can be stopped quickly, safely, and accurately by a slight foot-pressure on a remote-control pedal.

Today in many instances women in war plants have taken over that job—Wagner industrial hydraulic brakes have made it possible. These efficient industrial hydraulic brake systems are used extensively, not only on overhead cranes, both for indoor or outdoor operation, but also on bending-rolls, scrap-balers, large wheel-balancers, and similar applications when it is desirable to decelerate the machine by foot-pressure for either normal or emergency stops.

Write for Bulletin IU-20

Users of overhead cranes, as well as every maintenance man responsible for the safe and efficient operation of overhead cranes, should have this bulletin. A post-card will bring it to you.

I 44-11

MOTORS
TRANSFORMERS
UNIT SUBSTATIONS
INDUSTRIAL BRAKES
BRAKE LINING

ARMY (E) NAVY

NATIONAL SECURITY AWARD

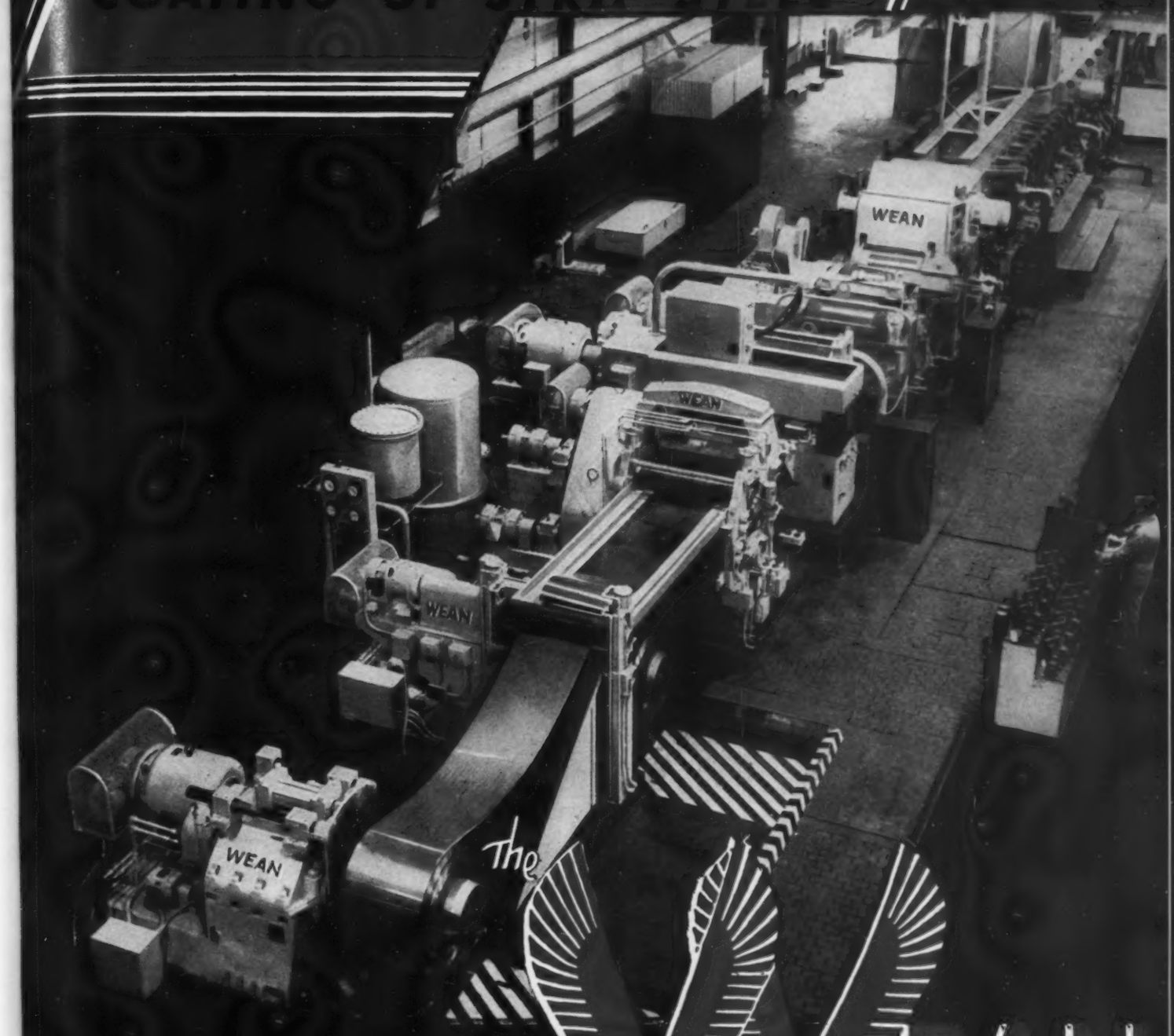
Wagner Electric Corporation

ESTABLISHED 1891

6483 Plymouth Avenue, St. Louis 14, Mo., U. S. A.

ELECTRICAL AND AUTOMOTIVE PRODUCTS

WEAN EQUIPMENT FOR THE CONTINUOUS COATING OF STRIP STEEL



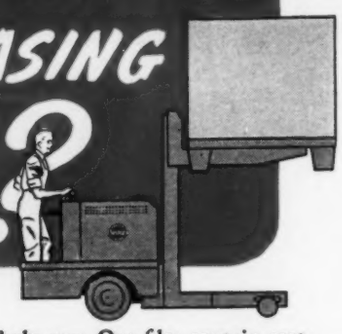
THE Wean Engineering Company is meeting today's demand for equipment to produce tin plate and zinc coated strip steel with light coatings by the electrolytic method; also equipment to produce chemically treated black plate and strip steel. Equipment for coating strip steel with zinc and other materials by the hot dip method is also available.

The WEAN ENGINEERING COMPANY, Inc.
Warren, Ohio

Subsidiary Company
THE BRODEN CONSTRUCTION CO.
CLEVELAND, OHIO

SPECIALISTS IN SHEET, TIN AND STRIP MILL EQUIPMENT

Is Your Problem One Of Increasing Production?



If so, a Baker Material Handling Engineer can help you. Our files contain case histories of hundreds of plants which have realized their objective through an improvement in handling operations with Baker Trucks. Many of these are illustrated in the new Baker Catalog. A few typical examples are illustrated below.

★ ★ ★

One manufacturer doubled productive capacity without enlarging his plant by constructing a mezzanine floor, and substituting a Baker Crane Truck for overhead cranes removed. The truck further helped production by speeding assembly and handling operations beyond limits of craneways. *(See illustration, left.)*

An aircraft manufacturer uses a Baker Fork Truck for keeping materials and products on the move. Illustration at right shows the truck lining up crated engines for inspection, after which it loads them into box cars for shipment. Carloading with Baker Trucks can release many men for productive work. *(See illustration, right.)*

With the addition of a motor-driven winch, the Baker Hy-Lift Truck at the left, makes die-changing a simple task, enabling one operator to do the work of several in much less time. By reducing idle press time, these trucks increase the productive capacity of plant equipment. The same truck also stores the dies in space-saving racks, and serves as a conventional truck, speeding other handling operations. *(See illustration, left.)*

Baker Crane Trucks spot heavy, bulky parts into position, speeding operations on an assembly line. Crane truck at right is moving an airplane fuselage into position. The same truck also assists in installing engines and propellers, and performs other heavy duty in the plant. *(See illustration, right.)*

A large aluminum manufacturer employs women to operate Baker Fork Trucks handling press forgings and other material. This releases experienced manpower for other productive work. By reducing distance within the plant Baker Trucks make practical use of remote areas. *(See illustration, left.)*

Man and machine time can be conserved by having material at hand when and where needed. Baker Low-Lift Truck keeps machine and operator busy by bringing and removing work—at the same time keeping aisles clear, promoting plant safety. *(See illustration, right.)*

★ ★ ★

If you have a material handling problem and are looking for the best answer, The Baker Material Handling Engineer nearest you will gladly help you. Or, write us direct.

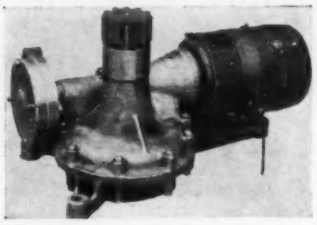
BAKER INDUSTRIAL TRUCK DIVISION *of The Baker-Raulang Company*

2166 West 25th Street • Cleveland, Ohio

In Canada: Railway and Power Engineering Corporation, Ltd.

LOOK AT THESE BAKER CONSTRUCTION FEATURES BEFORE YOU BUY AN INDUSTRIAL TRUCK

Every part of every Baker Truck has been especially designed for its specific function. Many Baker Features are exclusive. Others, pioneered by Baker, are now standard in the industry.

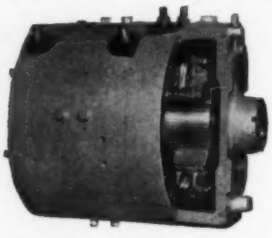


SLEW UNIT ON CRANE TRUCKS

The slewing unit on Baker Crane Trucks employs a pinion meshing with the bull gear mounted underneath the superstructure. A compound motor maintains uniform speed whether loaded or empty, and a magnetic brake insures prompt stopping.

BAKER SAFETY INTERLOCK

Contactor interlocked with controller and brake, makes and breaks travel motor circuit, confining arcing to contactor thus minimizing burning of controller contacts. Circuit can be closed only with brake released and controller set for first speed, eliminating starting without operator in position. Raising of pedal automatically applies brake and stops truck, a safety feature when truck stops on a grade or when operator leaves his position.

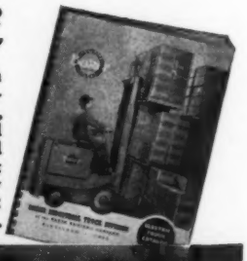


BAKER TRAVEL MOTOR

All motors are designed and built by Baker to give greatest efficiency for their specific function. Truck motors develop highest H. P. and contain more copper and iron than any others of the same size. Top efficiency is assured by ground fit between field ring and poles, heavy forged commutator bars and large brush surface. Brushes and armature shafts are easily accessible for adjustment or replacement.

WRITE FOR YOUR COPY

Plant and production managers, traffic managers, superintendents, purchasing agents and any others concerned with material handling will find the new Baker Catalog No. 52 a valuable reference.



Baker INDUSTRIAL TRUCKS

Tentative Program

ANNUAL ENGINEERING CONFERENCE

ASSOCIATION OF IRON AND STEEL ENGINEERS

Pittsburgh

WILLIAM PENN HOTEL

SEPTEMBER 25 - 26 - 27, 1944

Monday, September 25

9:00 A.M. — REGISTRATION — Silver Room.

Chairman:
J. D. JONES
Chief Engineer
Youngstown Sheet and Tube Company
Youngstown, Ohio

Vice-Chairman:
G. H. ROSE
Assistant to Vice President
American Steel and Wire Company
Cleveland, Ohio

9:15 A.M. — BUSINESS SESSION — Urban Room.

Chairman:
CHAS. L. McGRANAHAN
Assistant General Superintendent
Jones and Laughlin Steel Corporation
Pittsburgh, Pennsylvania.

Secretary:
F. H. DYKE
Assistant General Manager Steel Plant
Wheeling Steel Corporation
Steubenville, Ohio

9:30 A.M. — ELECTRICAL DIVISION — Urban Room.

Chairman:
J. H. MILLER
Electrical Superintendent
International Harvester Company
Wisconsin Steel Works
Chicago, Illinois

Vice-Chairman:
R. W. GRAHAM
Electrical Superintendent
Bethlehem Steel Company
Lackawanna, New York

"Characteristics of Crane Hoists," by M. A. Whiting and J. A. Jackson, Industrial Engineering Division, General Electric Company, Schenectady, New York.

"Selection and Maintenance of Magnetic Brakes," by A. E. Lillquist, Supervising Engineer, Engineering Department, Cutler-Hammer, Inc., Milwaukee, Wisconsin.

Symposium — "Communication Systems in Steel Plants." (Speakers to be announced.)

1:30 P.M. — MECHANICAL AND WELDING DIVISION — Cardinal Room.

Chairman:
F. C. SCHOEN
Plant Engineer
The Midvale Company
Nicetown, Philadelphia, Pennsylvania

Vice-Chairman:
T. R. MOXLEY
General Master Mechanic
Wheeling Steel Corporation
Steubenville, Ohio

"Welding and Cutting Applications in Steel Plant Maintenance," by S. D. Baumer, Steel Mill Representative, Air Reduction Sales Company, New York, New York.

"Alloy Steels for Maintenance in the Steel Plants," by J. A. Rosa, Metallurgical Department, Republic Steel Corporation, Massillon, Ohio.

"Maintenance With Low Temperature Welding," by R. D. Wasserman, President, Eutectic Welding Alloys, Inc., New York, New York.

1:30 P.M. — OPERATING PRACTICE DIVISION — Urban Room.

Chairman:
A. S. GLOSSBRENNER
General Superintendent
Youngstown District
Youngstown Sheet and Tube Company
Youngstown, Ohio

Vice-Chairman:
R. H. GELDER
Works Metallurgist
American Rolling Mill Company
Ashland, Kentucky

"The Unitemper Mill," by M. D. Stone, Manager, Development Department, United Engineering and Foundry Company, Pittsburgh, Pennsylvania.

"Shearing Flat Rolled Steel," by F. E. Flynn, District Manager, Republic Steel Corporation, Warren, Ohio, and D. A. McArthur, Chief Engineer, Wean Engineering Company, Warren, Ohio.

"The Place and Effect of Conveyor Equipment in Industry," by J. E. McBride, Vice President, Palmer-Bee Company, Detroit, Michigan.

Symposium — "Cleaning of Steel for Subsequent Coating." (Speakers to be announced.)

8:00 P.M. — Motion Pictures, selected subjects — Urban Room.

Tuesday, September 26

9:00 A.M. — ROLLING MILL DIVISION — Urban Room.

Chairman:
LOUIS MOSES
Superintendent, Rail Mill and Roll Department
Bethlehem Steel Company
Sparrows Point, Maryland

Vice-Chairman:
F. G. KREDEL
Superintendent, Bar Mills
Republic Steel Corporation
Cleveland, Ohio

"Salvaging Alloy Steel Rolls," by H. L. Watson, Jr., Superintendent, Special Products Department, The Midvale Company, Nicetown, Philadelphia, Pennsylvania.

"Structural Mills and Structural Mill Roll Design," by Ross E. Beynon, Superintendent Roll Shop Department, Carnegie-Illinois Steel Corporation, South Chicago, Illinois.

"Billet Preparation for Rolling Mills," by F. F. Cambest, General Foreman, Steel Supply and Preparation, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania.

1:30 P.M. — COMBUSTION DIVISION — Cardinal Room.

Chairman:
E. E. CALLINAN
Combustion and Refractory Engineer
Steel and Tube Division
Timken Roller Bearing Company
Canton, Ohio

Vice-Chairman:
J. J. ALEXANDER
Assistant Power Superintendent
Republic Steel Corporation
Cleveland, Ohio

"The Problem of Reversing Regenerative Furnaces," by J. P. Vollrath, Industry Engineering Department, and J. R. Green, Manager Steel and Ceramic Division, Brown Instrument Company, Philadelphia, Pennsylvania.

"Developments in Rotary Hearth Furnaces," by J. H. Loux, Salem Engineering Company, Salem, Ohio.

"The Continuous Determination of Oxygen and Combustibles in Furnace Flue Gases," by John F. Luhrs, Research Department, Bailey Meter Company, Cleveland, Ohio.

1:30 P.M. — ELECTRICAL DIVISION — Urban Room.

Chairman:
E. L. ANDERSON
Electrical Superintendent
Bethlehem Steel Company
Johnstown, Pennsylvania

Vice-Chairman:
L. R. MILBURN
Electrical Engineer
Great Lakes Steel Corporation
Ecorse, Detroit, Michigan

"Increasing the Power on Existing Cold Mills," by F. R. Burt, Industrial Engineer, and B. J. Auburn, Electrical Engineer, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

"The Electronic Frequency Changer," by A. G. Darling and L. W. Morton, General Electric Company, Schenectady, New York, and F. W. Cramer, Electrical Engineer, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania.

"Blast Furnace Skip Hoist", by Gordon Fox, Vice President, Freyn Engineering Company, Chicago, Illinois.

7:00 P.M. — INFORMAL STAG DINNER — Ball Room.
(Speakers to be announced.)

Wednesday, September 27

9:00 A.M. — OPERATING PRACTICE DIVISION — Urban Room.

Chairman:
W. H. COLLISON
Superintendent, Coke Plant, Blast Furnace Division
Great Lakes Steel Corporation
Ecorse, Detroit, Michigan

Vice-Chairman:
H. W. CAMPBELL
Plant Engineer
Interlake Iron Corporation
Toledo, Ohio

"Gas Turbines for Blast Furnace Blowers," by Paul R. Sidler, Electrical Engineer, Brown, Boveri & Company, Limited, New York, New York.

"Design and Operation of Modern Sintering Plants," by C. J. Duby, Chief Engineer, Warren District, Republic Steel Corporation, Warren, Ohio.

"Performance of Large Hot Blast Stoves," by B. B. Frost, Service Engineer, Arthur G. McKee Company, Cleveland, Ohio.

1:30 P.M. — COMBUSTION DIVISION — Urban Room.

Chairman:
L. N. McDONALD, Jr.
Chief Power and Fuel Engineer
Carnegie-Illinois Steel Corporation
Youngstown, Ohio

Vice-Chairman:
C. J. WYROUGH
Superintendent, Steam Efficiency and Combustion Department
Jones and Laughlin Steel Corporation
Pittsburgh, Pennsylvania

"Blast Furnace Gas in Modern Steam Generating Units," by Frank X. Gilg, Service Department, The Babcock and Wilcox Company, New York, New York.

"New Open Hearth Furnaces at Homestead," by H. J. Pugsley, Engineer, Swindell Dressler Corporation, Pittsburgh, Pennsylvania.

Round Table Discussion — "Disposition of Coke and Blast Furnace Gas." (Speakers to be announced.)

1:30 P.M. — LUBRICATION DIVISION — Cardinal Room.

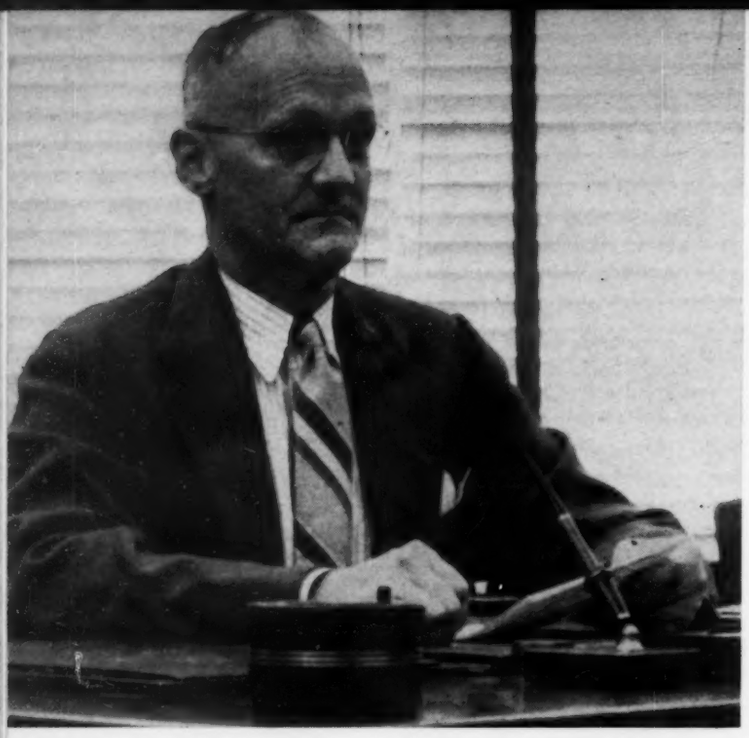
Chairman:
C. E. S. EDDIE
Lubrication Engineer
Great Lakes Steel Corporation
Ecorse, Detroit, Michigan

Vice-Chairman:
S. C. GRIFFITH
Lubrication Engineer
Jones and Laughlin Steel Corporation
Pittsburgh, Pennsylvania

"Use of Demulsifiers in Circulating Oil Systems", by T. G. Roehner and E. S. Carmichael, Socony-Vacuum Oil Company, Brooklyn, New York.

"Additives in Lubricants," by C. E. Pritchard, Lubrication Engineer, Republic Steel Corporation, Cleveland, Ohio.

"Current Developments in Industrial Lubricants and Their Influence on Post-War Products," by G. F. Bowers, Standard Oil Company of Indiana, Chicago, Illinois.



To the Steel Industry

As the time nears for what we hope will be the last wartime engineering conference of the Association of Iron and Steel Engineers, the iron and steel industry can look back over a truly enviable record of production achievement — a record that might, at the start, have been thought impossible — a record made in spite of the handicaps imposed by strikes and the shortages of manpower and certain materials.

But in looking back at our achievements we must not allow our forward momentum to slacken. There is still the matter of finishing the war, and no war can be won by the glories of the past. You cannot kill the enemy by throwing the history book at him. It takes fighting and the materials of war — and that means production.

There is another reason for keeping our sights trained forward, and, at the risk of being accused of "home front complacency," I might say one almost as important as finishing the war. I refer to the post-war period.

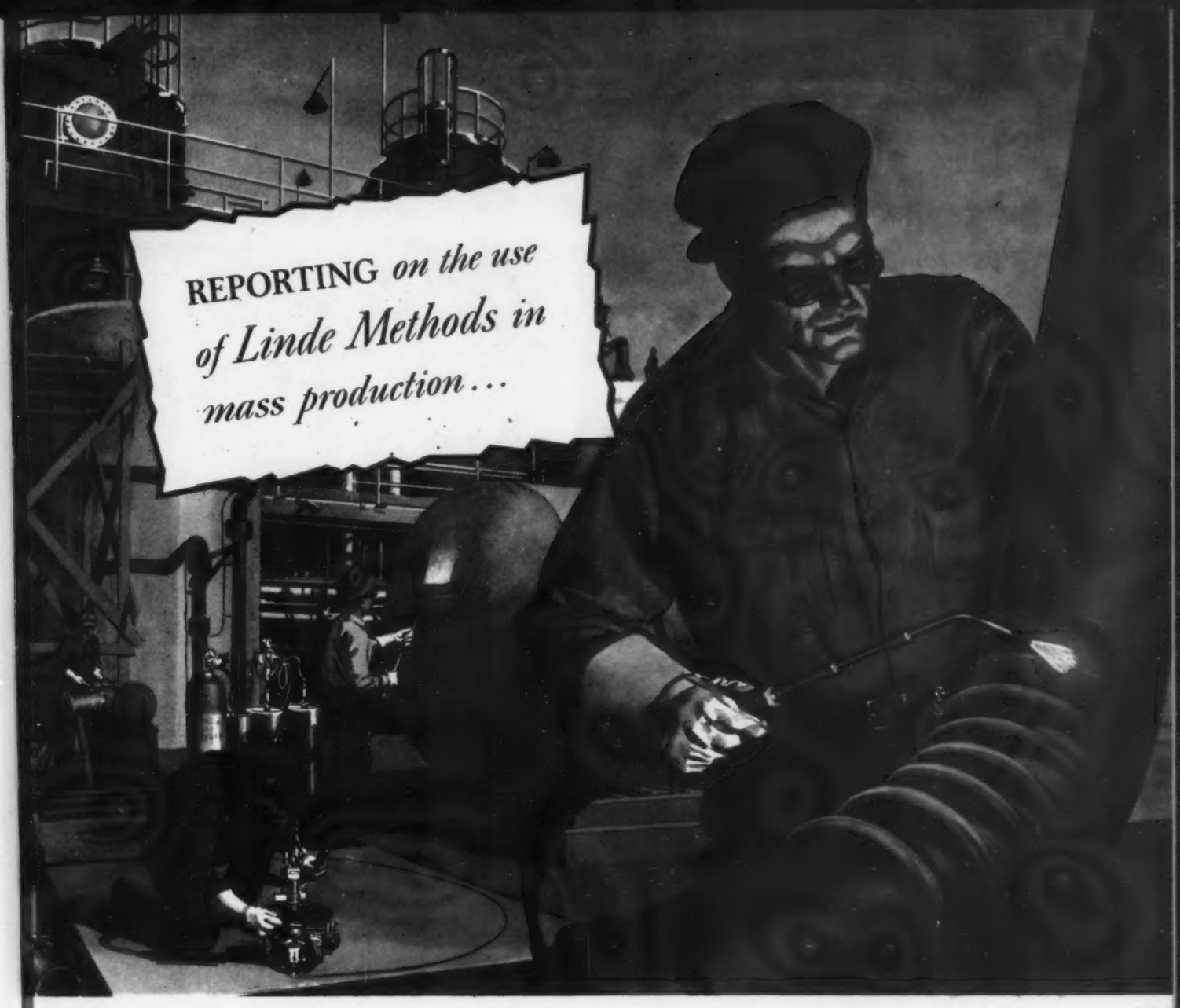
There is no doubt that steel will be faced with competition much more severe than in pre-war days. Greatly expanded capacities for the production of aluminum, magnesium and brass will give a peacetime surplus which will seek to cut in on steel's markets, to say nothing of the developments in plastics. Furthermore, our expanded steel capacity will tend to eliminate the inefficient producers.

Thus the steel industry faces a definite post-war problem — one that calls for the exercise of just as much ingenuity and resourcefulness as do our production problems. We cannot pause for self-congratulatory reminiscence, but must think and plan now for peacetime production, even as we continue wartime production.

To this end we have devoted a portion of the technical program of our annual engineering conference, and I wish to extend an invitation to the engineering and supervisory personnel of the iron and steel industry to participate in this meeting. Through such meetings we have in the past contributed very materially to production accomplishments and we feel that the results merit continuation of these activities.

Chas. L. McGranahan

PRESIDENT



PIPE—like many other metal products—is produced and fabricated faster and at less cost with the help of LINDE METHODS

The oxy-acetylene processes shown here . . . flame-cutting, welding, wrinkle-bending, and flame-priming . . . are but a few of the Linde methods used daily to save time, money, and materials in fabrication of industrial piping . . . piping for synthetic rubber plants, power stations, petroleum refineries, ships, chemical units, and mills and factories of all kinds.

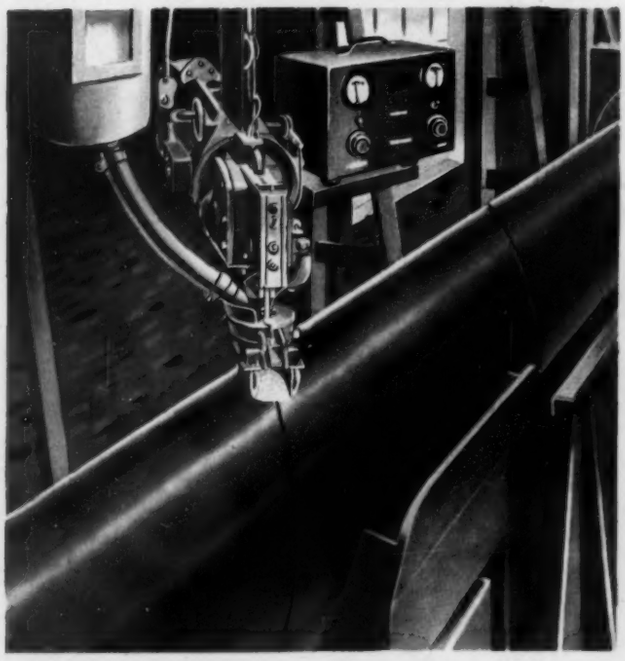
Linde's method of wrinkle-bending pipe, for example, quickly produces smooth-sweep bends to fit the system as work progresses . . . without need for fittings. Wrinkle-bending also is used to a great extent in the construction of overland pipe lines.

There are other Linde methods to speed construction . . . methods for flame-shaping steel plate for storage tanks by means of portable oxy-acetylene cutting machines . . . for flame-priming structural steel and plate to make paint last longer . . . and for cutting and welding together sections of pipe to fit a variety of needs.

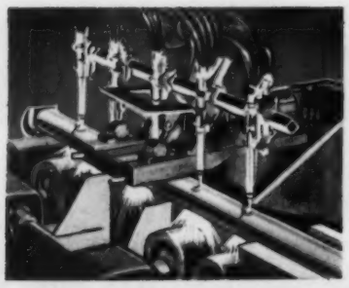
Linde-developed processes also are important in the production of pipe and tubing as well as in its fabrication. In the next three pages you can learn more about some of these Linde developments. The pictures and captions may suggest useful applications in your business.

Methods developed by THE LINDE AIR PRODUCTS COMPANY

MAKING PIPE



UNIONMELT Welding – Makes high-quality welds in steel of any thickness at unusually high speeds. This automatic electric welding process is used to fabricate spiral pipe, as well as to make storage tanks, ships, aircraft parts, and many other types of equipment.

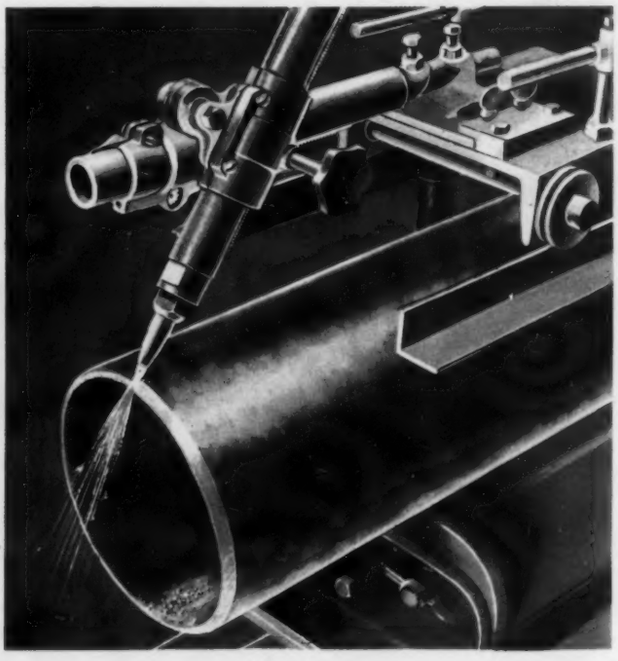


Cutting Pipe Rounds – Oxy-acetylene machines like this cut billets to length; others gouge starting holes for piercing to make seamless pipe.

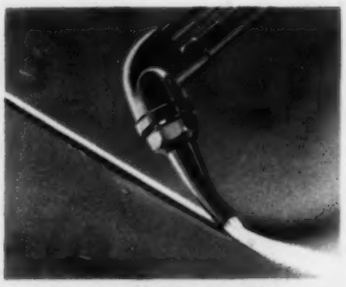
Tube Welding – In making welded tubing, edges of steel strip moving at high speeds through forming rolls are joined by oxy-acetylene flames.

Preparing Plate-Edges – Flame-cutting equipment speeds trimming and beveling of plate preparatory to welded fabrication of large-diameter pipe.

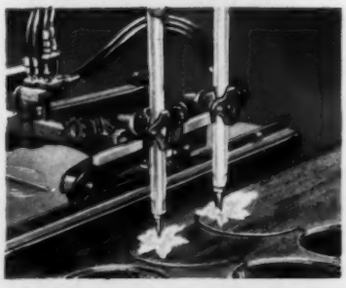
CUTTING PIPE



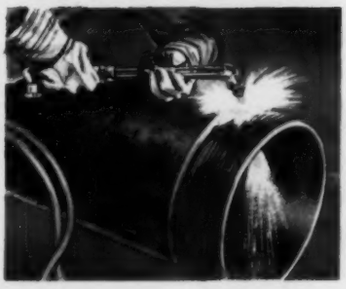
Beveling Pipe – The ends of pipe to be joined by welding must be cut uniformly—and, whenever the walls are more than 3/16 in. thick, the ends must be beveled to make possible complete weld penetration. This work is done quickly by oxy-acetylene cutting, using mechanized or manual equipment.



Gouging – Cutting blowpipes equipped with gouging nozzles quickly remove surface metal, such as temporary welds, without harm to adjacent areas.



Fabricating Flanges – Flame-cutting machines quickly and accurately produce pipe flanges of any size or thickness from stock steel plate.

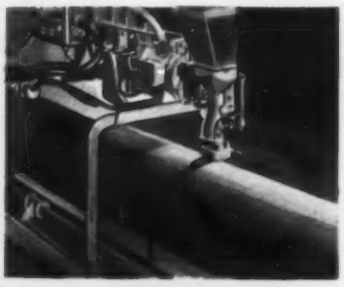


Reclaiming, Altering – Flame-cutting speeds on-the-job reclamation of old pipe, and extension or alteration of existing piping systems.

are important in the Production and Fabrication of Pipe

JOINING PIPE

Pipe Welding – Piping systems that are strong, compact, leak-proof, and practically maintenance-free can be fabricated into an integral unit by oxy-acetylene welding. The smooth interior and exterior walls of flame-welded piping provide high flow efficiency and make insulation easier where this is required.



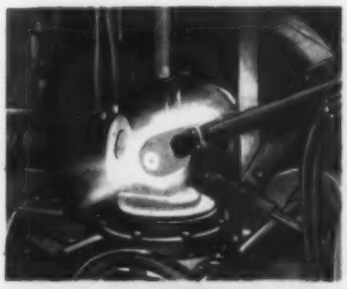
Double-Lengthing – Joining pipe into long lengths at a central location reduces manual welding work in the field. Here it is being done by the UNIONMELT automatic electric process.

Fabricating Fittings – Oxy-acetylene welding, used with flame-cutting, makes it possible to produce fittings from stock pipe at low cost, as needed.

Joining Copper Tubing – Air-acetylene torches provide the exact amount of controlled heat for installing copper tubing and solder-type fittings.

FORMING AND TREATING

Flame-Hardening – Oxy-acetylene flames, followed by a water quench, impart a hard, wear-resistant case to surfaces of carbon or alloy steel. Here, this process is being applied to the tool joints of oil well drill pipe. It also is used on such parts as gears, shafts, and other parts subjected to abrasive wear.

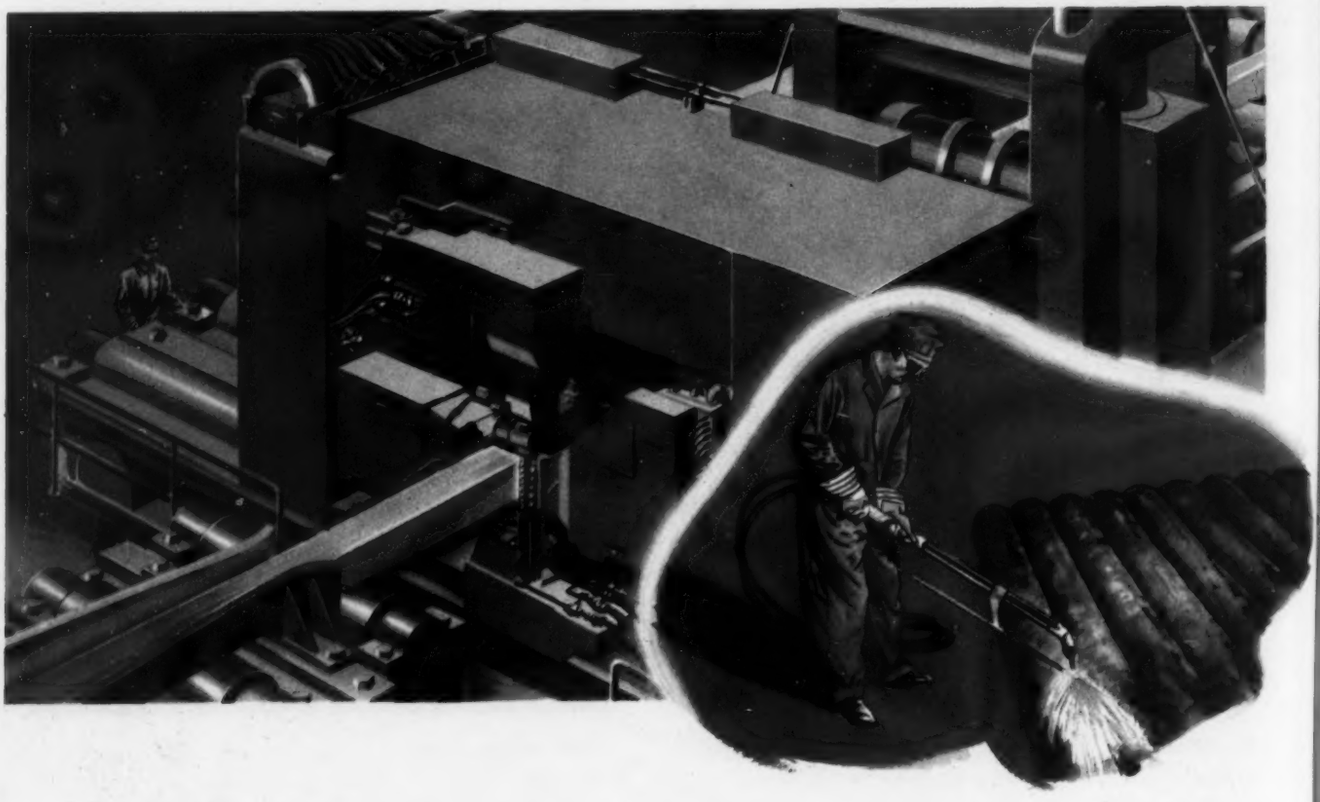


Flame-Spinning – Tubing heated by oxy-acetylene flames while spun rapidly can be quickly end-formed to eliminate deep-drawing operations.

Flame-Priming – Oxy-acetylene flames remove scale, rust, grease, and moisture from surfaces of pipe, tanks, and other steel preparatory to painting.

Flame-Straightening – Bent steel pipe, shafts, girders, or plates often can be trued up by applying oxy-acetylene flames at the right points.

LINDE METHODS SPEED PRODUCTION OF QUALITY STEEL USED FOR MAKING PIPE AND MANY OTHER PRODUCTS



A good example of how Linde-developed methods, based on the same principles as some of those shown on the three preceding pages, can be applied to fit specific needs of an industry is in the conditioning of semifinished steel. Oxy-acetylene flame-scarfing equipment, specially developed for steel mills, literally "skins" surface defects from billets, blooms, and slabs. This is done either as the steel rolls through on the production line by huge Linde machines such as the one shown above, or—after it has cooled and been removed from the roll table—by manually operated deseaming blowpipes as shown in the small drawing. This metal treatment results in higher yields of quality steel. In all industries where metal is worked, Linde methods can usually help to do the job faster, better, and at lower cost.

The folders shown at the left tell the story of the use of Linde methods in SHIPBUILDING, in STEELMAKING, and in METAL-FABRICATING. Copies will be sent to you upon request. Ask for Combination "A."

MARITIME "M" AWARD FOR OUTSTANDING PRODUCTION ACHIEVEMENT

THE LINDE AIR PRODUCTS COMPANY

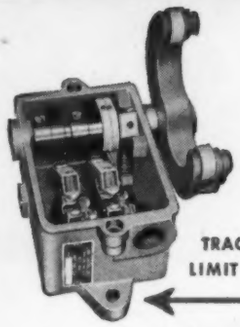
Unit of Union Carbide and Carbon Corporation

30 E. 42nd St., New York 17, N. Y. UCC Offices in Other Principal Cities

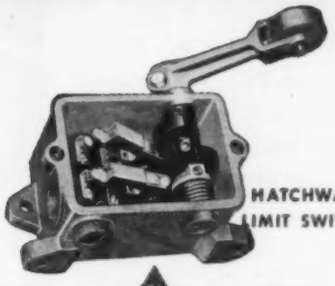
In Canada: Dominion Oxygen Company, Limited, Toronto

★ BUY UNITED STATES WAR BONDS AND STAMPS ★

ONE CONTACT FINGER ASSEMBLY FITS THEM ALL!



TRACK TYPE LIMIT SWITCH

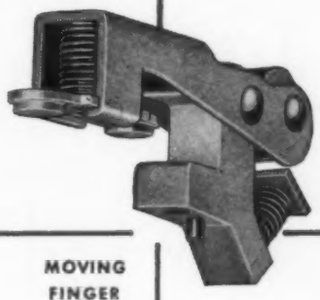


HATCHWAY LIMIT SWITCH

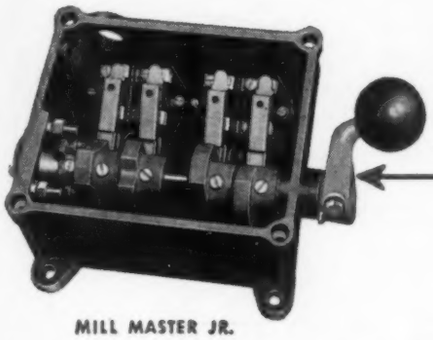
CRANE HOIST LIMIT SWITCH

The moving finger mechanism pictured in the center of this page fits every one of the accessory switches shown.

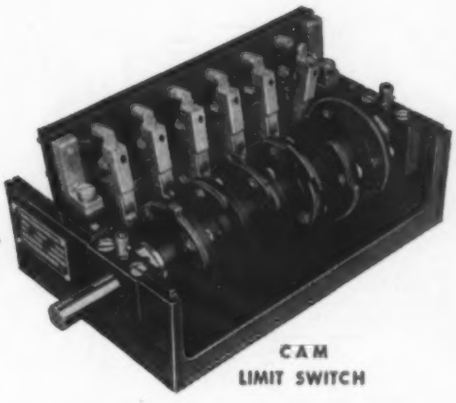
Thus, in plants using several different types of these switches, maintenance is simplified. One spare part fits them all.



MOVING FINGER MECHANISM



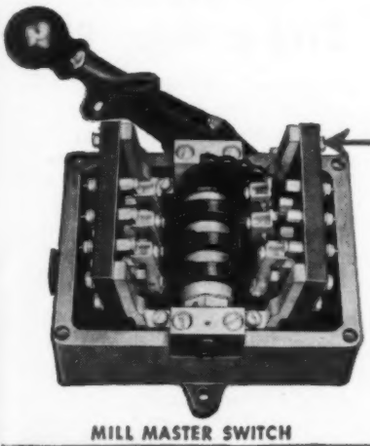
MILL MASTER JR.



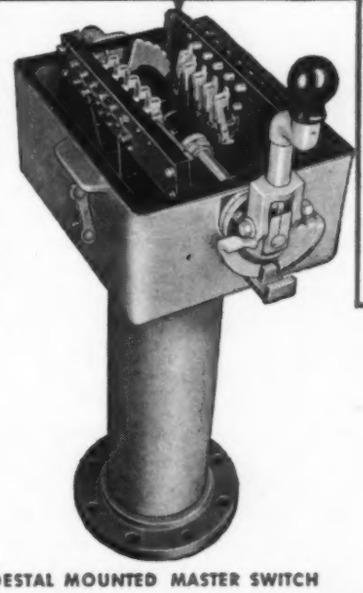
CAM LIMIT SWITCH

Double break, silver to silver contacts requiring no filing nor dressing also help cut maintenance.

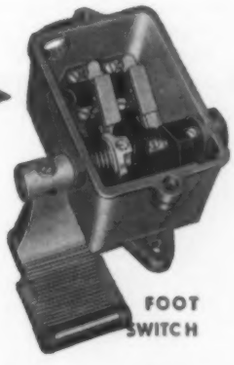
Minimum maintenance, even on such a small part as this moving finger assembly, helps speed production.



MILL MASTER SWITCH



PEDESTAL MOUNTED MASTER SWITCH

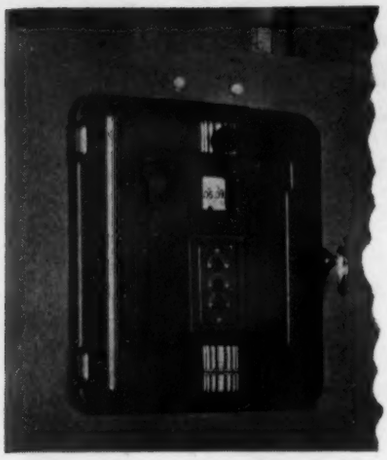


FOOT SWITCH

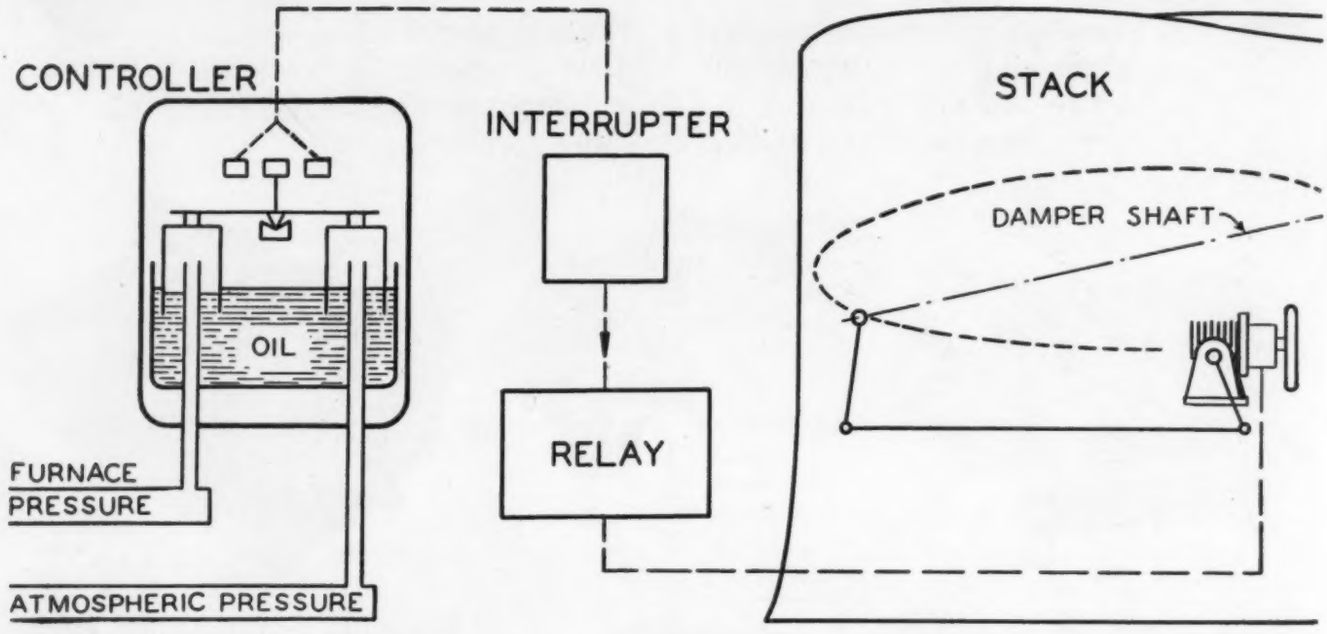
CONTINUE TO ROLL WITH CLARK CONTROL

THE CLARK CONTROLLER CO.

1146 EAST 152ND ST. CLEVELAND, 10, OHIO



← Set this Controller
And this Drive Unit →
regulates the damper
to carry out your
orders



Here's A "Smoother-Out" for Furnace Pressure

Almost any large, fuel-fired industrial furnace in which pressure is now being controlled by hand can be given much closer control by means of an L&N Furnace Pressure Controller. This equipment sharply reduces uneven pressure as a factor in furnace production; helps hold the flame shape and position, helps stabilize the combustion, and in general increases the furnace's net output.

The Controller handles the furnace just as the helper wishes — it will automatically hold pressure at a predetermined number of thousandths of an inch of water, or will permit manual control, at the helper's discretion. The shift from automatic to manual is made by simply flipping a switch.

No interference with the control of reversal, roof-temperature, etc., is involved in using this Controller. It consists, usually, of two assemblies — a panel with Controller and accessories, and a Drive Unit and linkages for the damper. Installation can be handled by the plant's crew, and maintenance is simple and slight.

The complete equipment is described in Catalog N-01A-600, sent on request. If you have a wartime problem, outline it and we'll send specific information.

Used in Many Plants

The equipment shown above is installed in a steel mill, and the Drive Unit employed is one of our larger sizes, because of the size and weight of the stack damper. A complete range of units enables the user to select the correct one for any torque from 25 lb ft up to 1000 lb ft, as the case may require. Open-hearth furnaces, soaking pits, slab and cake furnaces, cement and other rotary kilns are among the units in scores of plants which are using L&N Furnace Pressure Controllers with excellent results.

Jrl Ad N-01A-600(1)

A Slogan For Every American

LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

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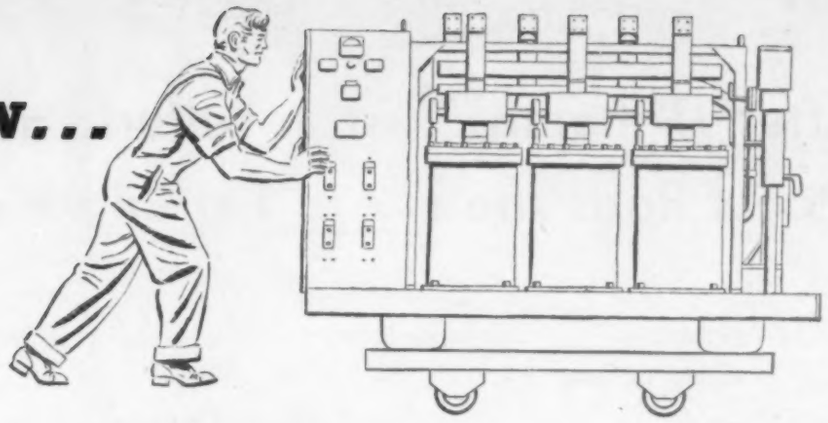
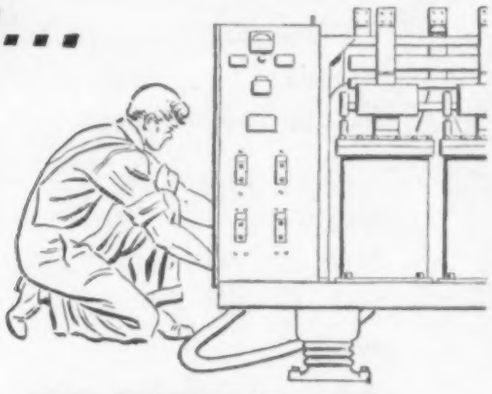


CONNECT IT...



It's easy to install an Ignitron Rectifier power conversion unit. Just move it on any reasonably level floor—connect the control leads, power leads and water supply—and it's ready to go to work. No air ducts or ventilating systems are required.

As the d-c load center changes, the entire Ignitron substation can be moved to new locations. Because of their lightweight, Ignitrons have been installed on balconies, since no special foundation is required.

Simplify your power conversion equipment. Save time—save money—save space. Specify Westinghouse Ignitron Rectifiers—a product of Westinghouse Electronic Research.

FORGET IT

IN THE STEEL INDUSTRY

High-load swings with extreme overloads and frequent short circuits are normal operating conditions for steel mill conversion equipment. Ignitron Rectifiers withstand extremely high momentary overloads and short circuits without damage to the equipment and without increase in maintenance.

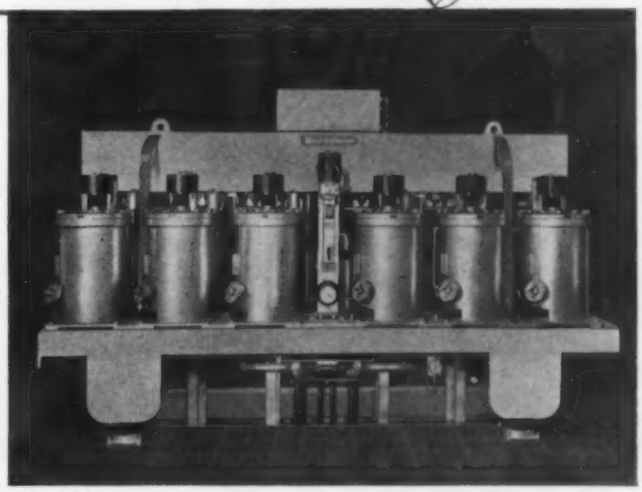
For further information write for Book B-3024. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., Dept. 7-N. J-10261-1

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

IGNITRON RECTIFIERS

Electronics at Work



After 11 months' test in sulfuric acid pickling Monel Rods show 3 to 1 strength advantage

The best measure of a tie-rod's merit is its ability to keep a pickling tank tight after a period of service.

This requires high corrosion resistance to maintain (1) the strength of the rod and (2) the structure of the threads on the end.

This illustration shows a cross-section of three metal rods... Monel, and two other metals frequently used in pickling... tested by the Research Department of a large steel mill after 11 months' service.

Monel *Metal "A"* *Metal "B"*

The rods, 1″ diameter by 18″ long, were bolted through a wooden rack and tested under actual plant conditions in a tank used for pickling hot-rolled sheets. The sulfuric acid content of the pickle was maintained at from 5% to 7% by weight. The operating temperature was 180° F.

After a total exposure of 331 days, or 2448 hours actual pickling time, metals "A" and "B" showed serious deterioration with only a residual core of the original metal remaining (see photos). The Monel rod had remained smooth, and was only slightly discolored. Load tests revealed that the Monel rod had over 3 to 1 strength advantage. The strength of rods "A" and "B" had been seriously impaired.

MAXIMUM LOADS SUSTAINED BY SPECIMEN TIE-RODS AT END OF TEST

Metals	*Maximum Load* (*Average of 4 or more rods*)
Monel	52,800 lbs.
Metal "A"	15,300 lbs.
Metal "B"	14,500 lbs.

The condition of the threads was noted and measurements made. At the critical point on the threads *ahead* of the nut, rods of metals "A" and "B" suffered attack that destroyed their usefulness. The Monel rod showed no significant attack at this vital spot, thus maintaining its full usefulness.

Tough, strong and highly resistant to corrosion, Monel showed in these tests, as it has in other tests and in years of practical service, that it is uniquely fitted for long-lived pickling equipment.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street **New York 5, N. Y.**

INCO NICKEL ALLOYS

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Sheet... Strip... Rod... Tubing... Wire... Castings

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... in use throughout the world wherever Steel is rolled!

Designs for all types and all sizes immediately available

• UNITED 46" Blooming Mill

To meet war requirements we greatly increased our Rolling Mill production facilities. Very soon we expect to be able to offer attractive deliveries on units duplicating existing designs of all types and all sizes of BLOOMING AND SLABBING MILLS, or modifications of them adapted to meet your specific requirements.

Recognized pre-eminence in technical research, and more than 40 years experience in the design, construction and installation of Rolling Mills and their auxiliary equipment for leading steel manufacturers throughout the world, is evidence of UNITED'S ability to serve you.

In planning for present or post-war expansions, you should consult with our engineering staff.

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Davy and United Engineering Company, Ltd., Sheffield, England
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(Section view: Note long distances from contact to contact and from contacts to ground.

QUELARC

The circuit breaking plugs and receptacles . . . ratings up to 200 amperes

Pyle-National plugs and receptacles are built to stand up in mill service, delivering dependable service with minimum maintenance. The exclusive QuelArc construction provides exceptional protection to contacts, for safe use as current rupturing devices. In the section view, note the complete enclosure of all contacts in insulating chambers which form an arc-trapping space. Note also the long distances from contact to contact and from contacts to ground. Contacts are individually renewable. Full ground protection is provided.

QuelArc plugs and receptacles are available in a complete range of styles, 2, 3, 4 wire types; ratings 20, 30, 60, 100, and 200 amperes. Many other types available for portable tools and control and instrument circuits. Write for general catalog 1100 with listings of all types.

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During the fifteen years of our existence, we have built up an enviable reputation in the electrical industry. Capable engineers, operators and purchasers of transformers, in increasing numbers, are expressing their complete confidence in the abilities and integrity of our Organization and the high quality of our product.

The trust placed in us by our customers made it possible for us to develop and build transformers as large as 30,000 KVA and as high in voltage as 165,000; to produce the largest air cooled welding transformers in the Country; to manufacture some of the largest transformers for electric arc furnaces; to develop and build transformers with underload tap changers, and to generally cover the complete and entire line of power and distribution transformers.

Accomplishments of such nature require a large and highly skilled organization and complete facilities, which we possess. These facilities, equipment and personnel are being continually improved and enlarged, thus enabling us to steadily broaden our field of operation.

We will continue to adhere to the policy which made the success of the first fifteen years possible and which enables us to look to the future with complete confidence.

We extend to you a cordial invitation to visit our well-appointed offices, our clean and well organized factories, and to meet the capable men and women in our Organization. We think you will find such a visit interesting and enjoyable.

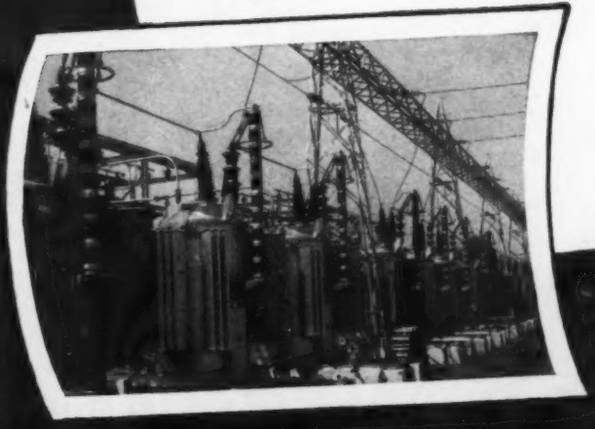
Sincerely yours,

PENNSYLVANIA TRANSFORMER COMPANY

Samuel Horelick

Samuel Horelick, President

SH:MP



a Bulletin

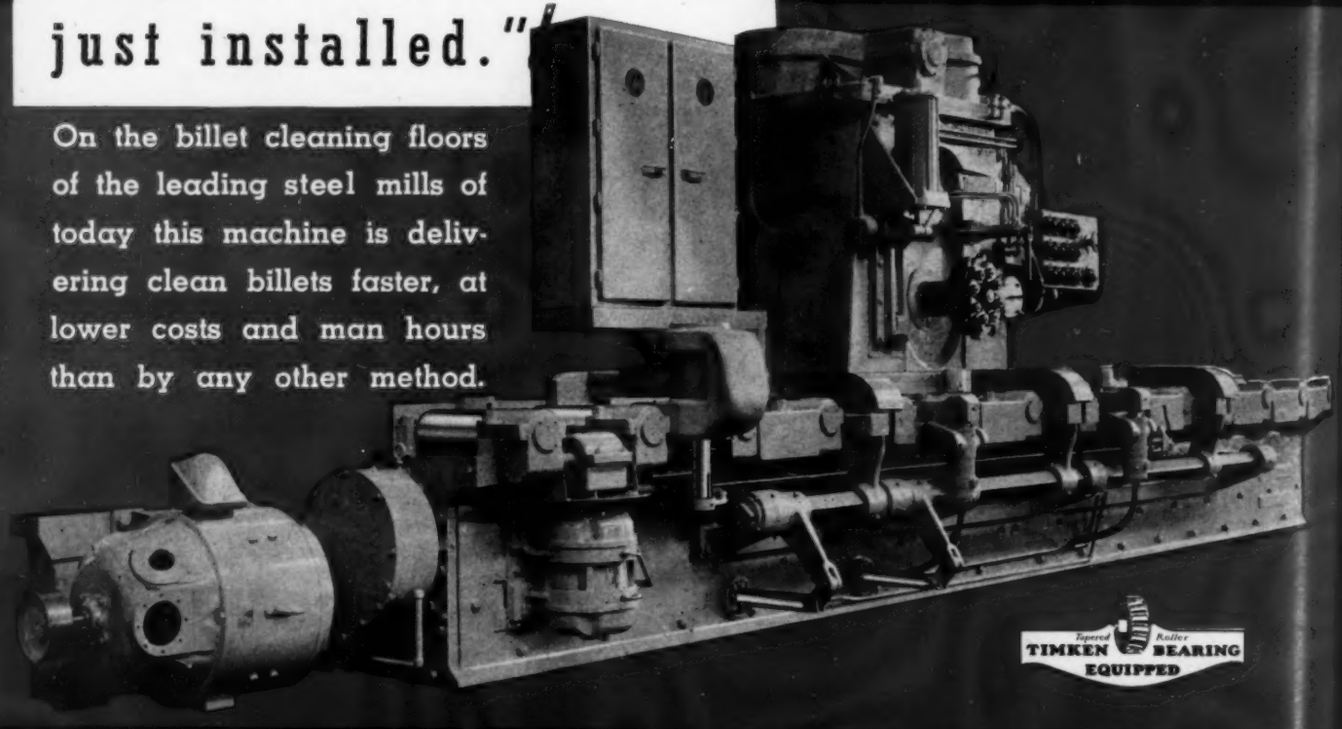
A Steel Executive Writes:

● "On our first Billeteer installation, our savings on chipping costs, everything included for the different types of alloys and varying sections, were from **$1.67** to **$3.33** per ton—or an average saving of **$2.50** per ton. This led to the purchase of the second machine just installed."

BONNOT PRODUCTS
ENGINEERED FOR IMPROVED PRODUCTION

INVESTIGATE THE SPEED & ECONOMY OF BILLETEERS and you will see why they are favored by the majority of mills.

On the billet cleaning floors of the leading steel mills of today this machine is delivering clean billets faster, at lower costs and man hours than by any other method.



Tapered Roller TIMKEN BEARING EQUIPPED

STEEL EQUIPMENT DIVISION OF **THE BONNOT COMPANY, CANTON, OHIO**

BONNOT

ENGINEERED FOR IMPROVED PRODUCTION

WRITE US FOR COMPLETE FACTS

"...but ONLY Okonite uses the Strip Process for insulating cables"

Inner strips of insulation are folded about the conductor.
Pure tin backing on the final layer forms a continuous metal mold.
With metal mold removed after vulcanization, the finished cable is ready for testing and shipment.

BECAUSE of the rubber shortage, *all* manufacturers have been forbidden by the government to use natural rubber in wires and cables for commercial use.

In 1942 it became apparent that Buna S would be the principal synthetic rubber to be used for insulation. However, the Okonite Company as early as 1930 had introduced Okolite, an oil-base insulation requiring only a small proportion of rubber.

In addition, in 1939 and before hostilities commenced, the Okonite Research Department had imported Buna S from Europe and it was not long before they found how to replace the small amount of natural rubber in Okolite with Buna S.

Extensive proving-ground tests have shown that Okolite made with Buna S possesses the same electrical and mechanical characteristics as when made with natural rubber. In addition, Okolite made with Buna S is applied to the conductor by the familiar Okonite Strip Insulating Process*.

While the industry, as a whole, is using Buna S rubber extensively, *only* Okonite uses the Strip Method to apply it. The Okonite Company, Passaic, New Jersey.

LOOK FOR THE ⬡ *SINGLE RIDGE*

*** THE OKONITE STRIP PROCESS**

The Okonite Strip Insulating Process is a unique and superior method of applying rubber insulation to a conductor.

Strips, cut from uniformly calendered sheets, are passed through "covering wheels". These strips are formed or folded lengthwise about the conductor and thus insure perfect centering.

One continuous operation is used to apply at least two or more layers, as required, the outermost layer being a strip with tin backing.

The insulated conductor is thus temporarily encased in a continuous tin mold. It is wound around a drum of large diameter, ready for vulcanization. The metal mold provides uniform heat distribution throughout the length.

After the cable has cooled, following vulcanization, the tin backing is peeled off as the finished wire is unwound from one reel and wound on another.

3737

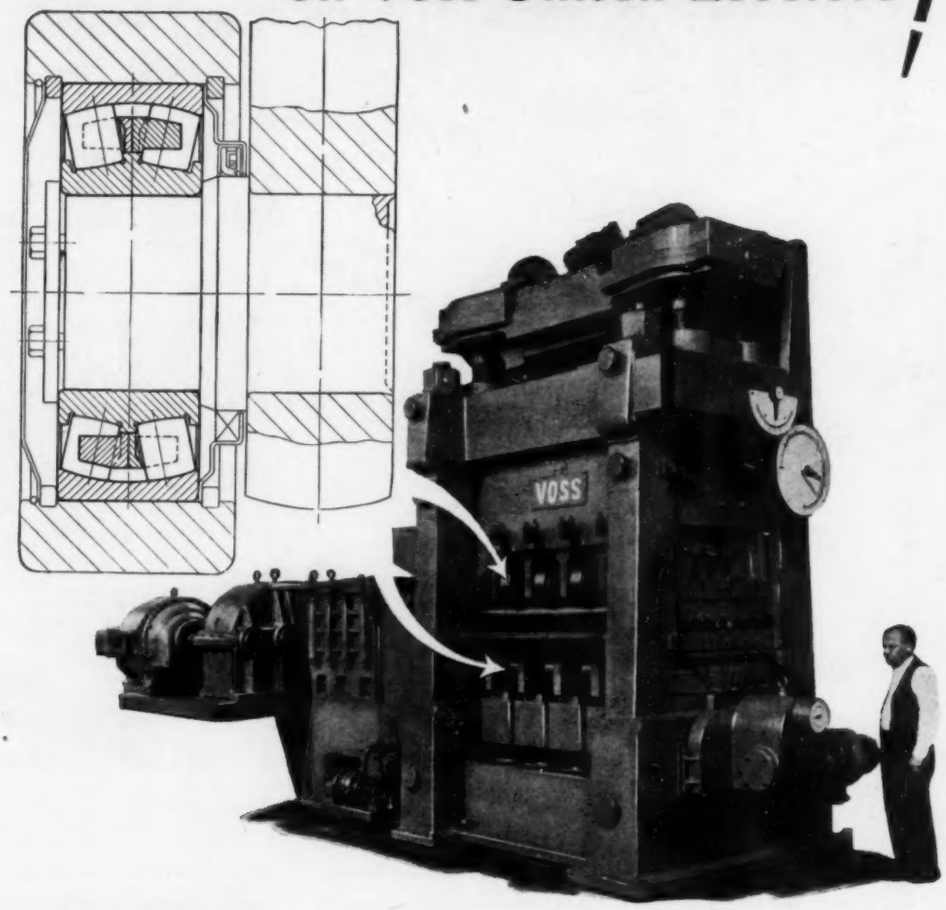
ARMY NAVY

OKONITE OKONITE SINCE 1878

INSULATED WIRES AND CABLES

For stabilizing work rolls

on Voss-United Levelers!



● *Besides the back-up rolls, SKF Spherical Roller Bearings are also used in the screwdown drives and in the work roll transmission of this Voss-United Leveler built by Voss Machinery Co.*

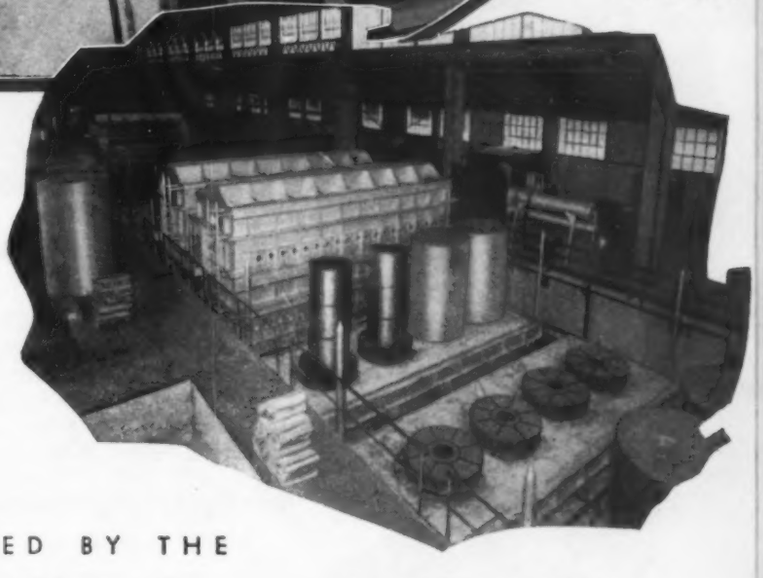
One of the roughest, toughest jobs for a bearing in the Steel Industry is to take grueling loads on a leveler. Yet SKF Spherical Roller Bearings take them with a smile. Because the leveling load is equally divided on two rows of rollers, SKF's have *equalized load distribution.* Because their self-alignment prevents excessive stress concentration due to binding or pinching, the *entire capacity* of SKF's is reserved for useful work. Because of these advantages and their low friction, SKF's have *long life.* The results are obvious. Work rolls are stabilized, and the production of armor plate ⅝″ thick by 60″ wide is uninterrupted by bearing trouble. 5604

SKF INDUSTRIES, INC., PHILADELPHIA 34, PA.

WILSON RECTANGULAR BELL *furnaces for* TIN PLATE COIL ANNEALING with VERTICAL RADIANT TUBES

One installation of 42 Furnaces and 126 Bases used exclusively for annealing tin plate coils.

The Wilson Annealing Unit is covered by Patents Nos. 1,952,402, 2,068,477, 2,078,356, 2,081,612, 2,099,843, and other patents pending.



LEE WILSON installed the first radiant tube fired furnaces for tin plate coil annealing in 1935. This installation now numbers 50 furnaces and 150 bases.

Many other plants have been equipped in the United States, Canada, England and most recently in South America. The newest developments in fan recirculation, coil diameters and piling heights are ready for the industry.

For maximum flexibility in production — a 4-stack unit.

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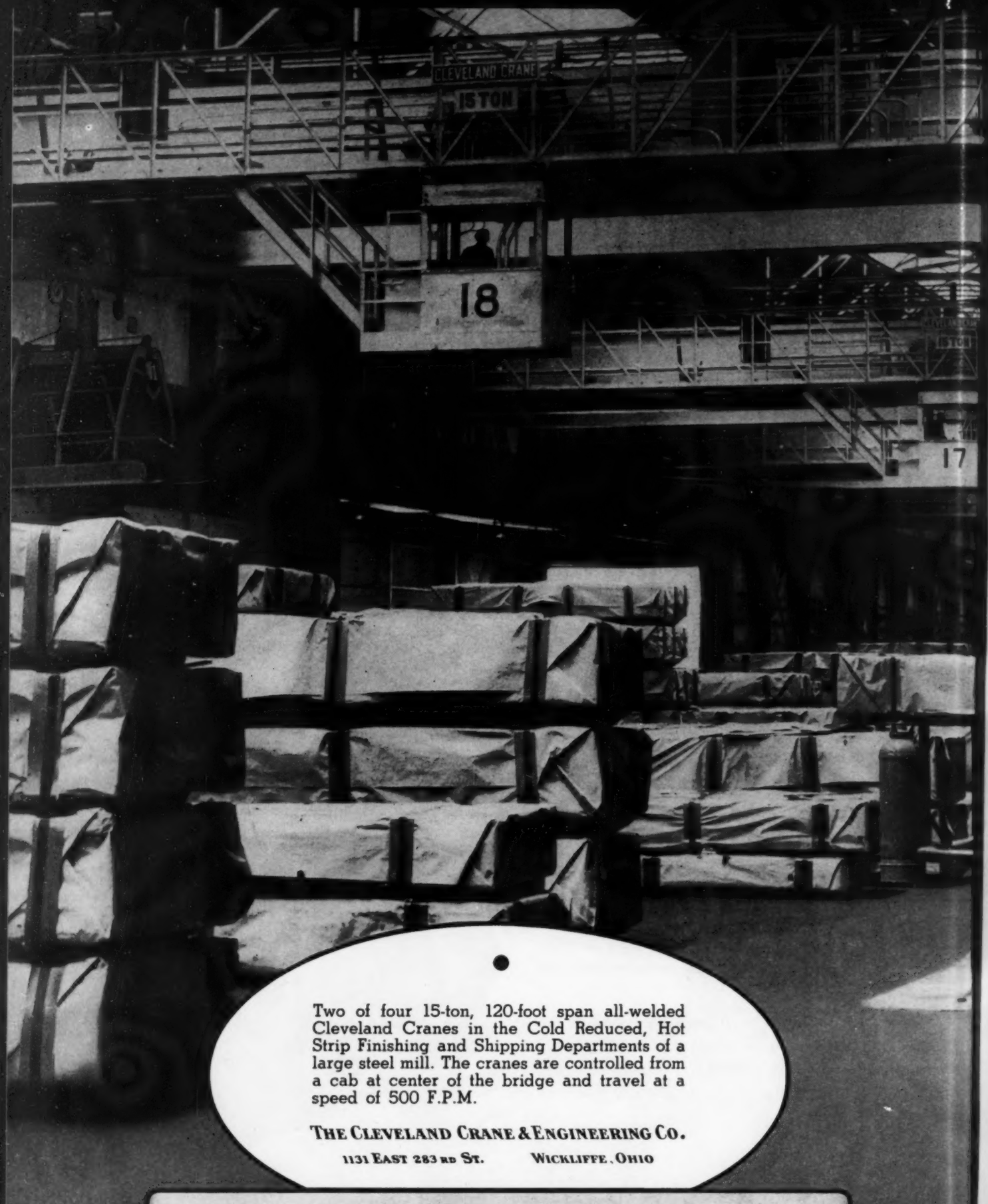
INDUSTRIAL FURNACES ★ RADIANT TUBE HEATING ★ HEAT TREATING PROCESSES



Two of four 15-ton, 120-foot span all-welded Cleveland Cranes in the Cold Reduced, Hot Strip Finishing and Shipping Departments of a large steel mill. The cranes are controlled from a cab at center of the bridge and travel at a speed of 500 F.P.M.

THE CLEVELAND CRANE & ENGINEERING CO.

1131 EAST 283 RD ST. WICKLIFFE, OHIO

CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

Crops *and* Shorts

THIS year is the 100th anniversary of an event of considerable moment to the steel industry. It was in 1844 that William A. Burt, leader of a surveying party in Michigan, noted the peculiar behavior of his compass needle, and upon searching, discovered several outcroppings of iron ore, the first of the Lake ranges which have meant so much to the industry.

▲

FIGURES brought out in testimony before the War Labor Board show that ore mining in the Lake fields is divided between the various production methods as follows:

Direct shipping pits	48,400,000 tons (58%)
Beneficiating pits	15,000,000 tons (18%)
Underground mines	20,600,000 tons (24%)
Total	84,000,000 tons

Employees in the various processes:

Direct shipping pits	5,350 men
Beneficiating pits	4,900 men
Underground mines	13,750 men

Manhours required per ton of ore in these processes run approximately .235 in the direct shipping pits, .70 in the beneficiating pits and 1.45 in the underground mines, with an overall average on the above schedules of .615.

Also mentioned was the fact that 25 per cent of the ore production does not come from "captive" mines owned by steel companies.

▲

ACCORDING to Godey's Lady Book, 1850, "the perfect hostess will see to it that the works of male and female authors be properly separated on her bookshelves. Their proximity, unless they happen to be married, should not be tolerated." Apparently introductions are not sufficient — there must be a wedding of the books, too.

▲

APPROXIMATE:Y 7 workers out of every 100 on factory pay rolls either change jobs or leave manufacturing work each month, according to Department of Labor statistics. Whether the new manpower rulings lower this figure remains to be seen.

AND now that it has been demonstrated that you can't get blood out of a turnip, it has been decided that 500 key men under the age of 26 in the steel industry will be deferred from selective service.

▲

IF anyone is interested, the deepest hole in the world according to Mining and Metallurgy for August, is an oil well in Texas — 20 in. in diameter at the top, 7.75 in. in diameter at the bottom and 15,279 ft. deep. Funny, but we've often left lower than that.

▲

THE high operating rate of the steel industry is continuing to drain the nation's scrap stockpile. Scrap produced and salvaged during the past year has been lower than consumption. Stocks of iron and steel scrap at plants of consumers, suppliers, and producers are said to stand now at less than 6,000,000 tons, the lowest since September, 1942, although the decline appears to have stopped in the last month or two. Some of the blame for this has been attributed to the fear of being caught with large inventories in case of suddenly curtailed operations.

▲

ANOTHER scrap headache of growing proportions is the contamination of carbon steel scrap with alloys. Some alloy scrap is moving at prices below those of carbon scrap, thus removing the incentive for segregation. Some mills are said to be encouraging the mixture of alloy and carbon scrap by accepting mixed shipments. A recent WPB check indicates that more than 50 per cent of the alloy scrap in steel plant inventories is of the triple alloy type.

▲

MOST guessing centers on October or November as (German) surrender months" . . . "a serious need for heavy shells" . . . "equipment for shell production will go into production the first of the year" . . . "production will drop 30 per cent with German surrender" . . . $103,000,000,000 worth of surplus war property will be on hand when wars end" . . . etc. Maybe it's old age or high blood pressure, but, like the confused pedestrian, we don't know which way to turn — and perhaps we're not alone.

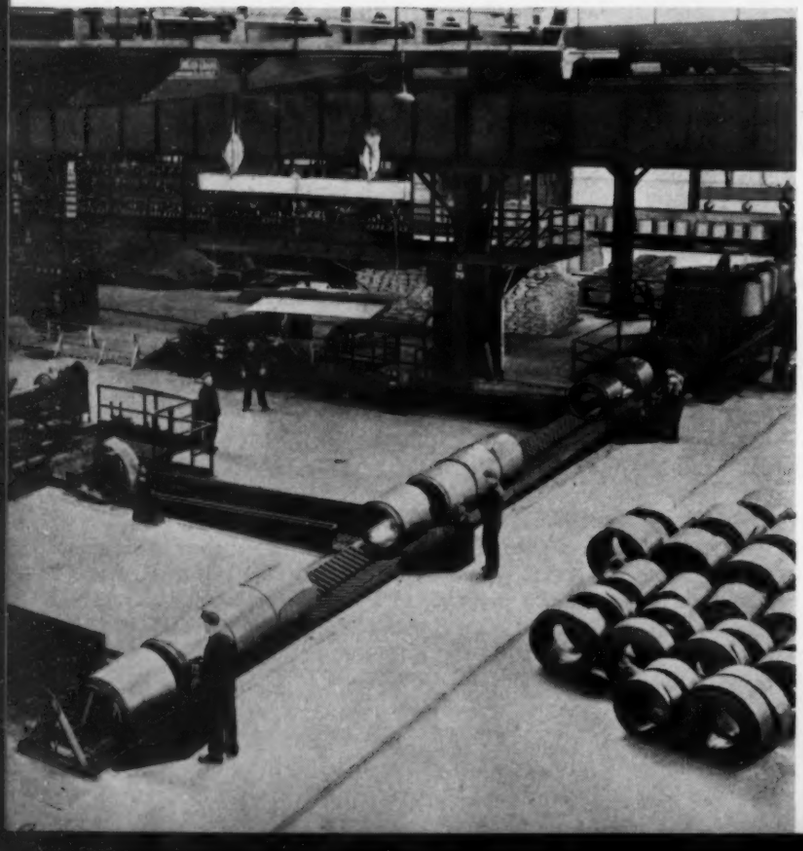
▲

RECENT figures from the Bureau of Census show that from April 1940, to July, 1943, the District of Columbia had a population increase of 34.2 per cent, highest in the nation. Its actual numerical increase was 226,902, a figure exceeded by only six states, two of which are its surrounding neighbors, Maryland and Virginia — just the old maxim "Go west, young man" in reverse.

▲

ACCORDING to WPB, manufacturers may now proceed with the development of some post-war models for peace-time manufacture, but the Army has put so many strings on the permission that it is of no use to many manufacturers. Looks as if we just have to wait for the unemployment problem.

MATHEWS CONVEYERS FOR MECHANIZED PRODUCTION



The fact that the production of war materials has reached its peak provides no basis for the assumption that manpower problems soon will cease to exist. The demand by the Armed Forces for men and women continues to be great. In industry, the tendency must be toward an increased number of women workers and older men. In this period, more than ever before, it becomes necessary to mechanize the handling of materials through processing, storage, shipping, and, in fact, wherever possible — to minimize lifting, pushing, and excessively fatiguing effort. Here, Mathews Engineering can help as it has done in thousands of great American and Canadian war plants during this emergency. Your Mathews Engineer can show you how modern Mathews methods can conserve manpower and promote economy in the materials-handling phase of your manufacturing.

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PENNSYLVANIA

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Iron and Steel ENGINEER

AUGUST 1944 VOL. XXI NO. VIII

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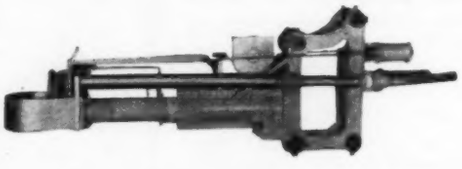

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THE ROLLING OF

Semi-Finished Steel

. . . . briefly outlining the methods and problems in rolling semi-finished steel . . . . much work still remains to be done in improving product and reducing costs . . . .

by Ross E. Beynon

SUPERINTENDENT, ROLL SHOP DEPARTMENT

CARNEGIE-ILLINOIS STEEL CORPORATION

SOUTH CHICAGO, ILLINOIS

▲ THE rolling of semi-finished steel products such as blooms, billets, slabs and sheet bars presents many interesting problems. This paper describes some of the mills used for making these products, the rolling practices generally used, and a brief discussion of roll design for this service.

BLOOMING MILLS

Blooming mills represent the first step in the process of rolling, and are used to reduce ingots to blooms, billets and slabs.

In the early days of rolling, ingots were smaller in size than at present, and were rolled on finishing mills direct to finished size. As the demand for larger ingots and greater lengths of products increased, a separate mill was needed where these large ingots could be rolled into blooms for the finishing mill. The blooms were then either reheated or rolled direct into the finished product.

Probably the first blooming mill built was at Dowlais, Wales, in 1866, and in the same year the first reversing rolling mill was built at Crewe, England. In 1867, George Fritz of the Cambria Iron Company, used 21 in. diameter blooming rolls to reduce an 8½ in. ingot to 6½ in. square. This is reported to be the first successful blooming mill in America.

After its development, the most commonly used type of blooming mill was the three-high unit in which a single size of ingot was rolled into one size of bloom. Many of these mills are still in use. The great disadvantage of the mill is that only one size of ingot can be handled and only one size of bloom produced. Such a mill is shown in Drawing 1.

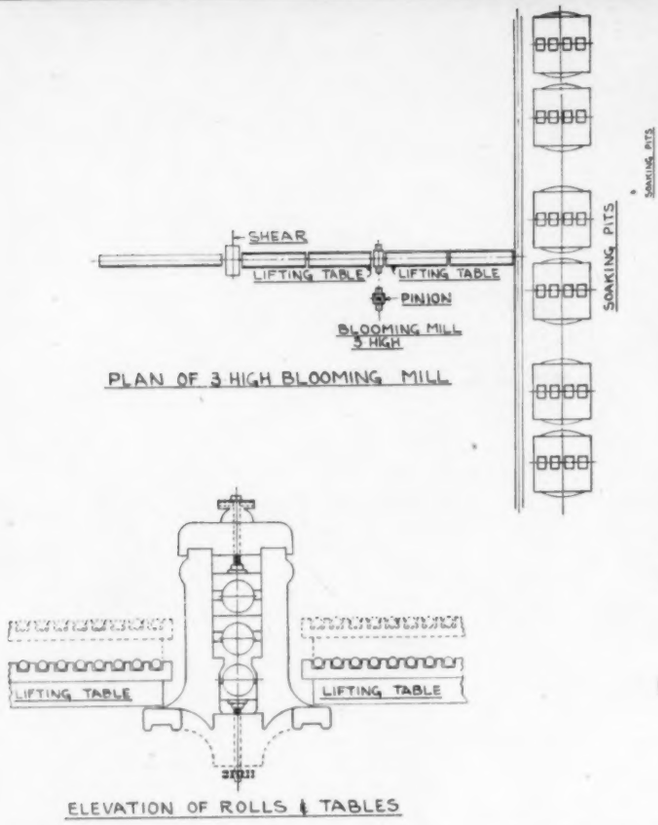
A modification of the original three-high mill still in use embodies a screwdown on the top and bottom rolls. This is an improvement over the fixed roll type as it makes the mill more flexible and permits the rolling of a number of bloom sizes. Drawing 2 illustrates a mill of this type.

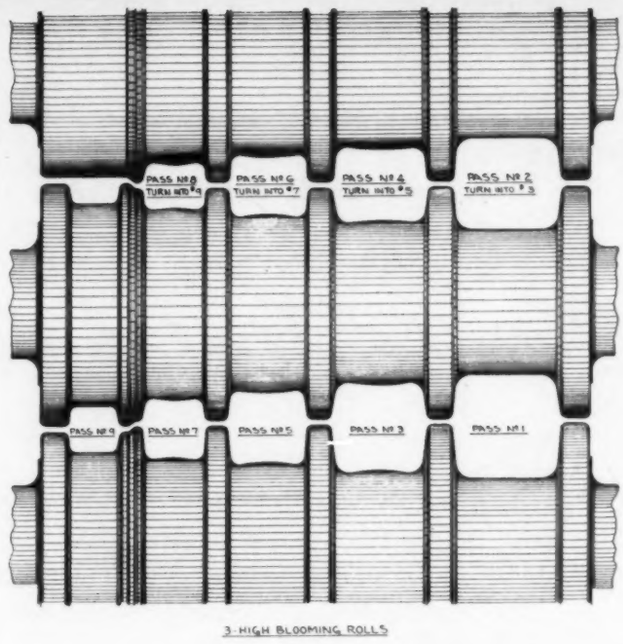
A more modern type of bloomer is found in the two-high reversing mill which may be considered as being the most flexible mill now in general use. It can take a wide range of ingot sizes and roll an almost unlimited number of bloom sizes. As a result it is by far the most useful type of bloomer built (see Drawing 3).

Still another type of blooming mill is the tandem mill. This consists of two reversing mills rolling in tandem, the reduction of the ingot being divided between the two mills. Such a mill has the advantage of faster blooming and greater tonnage, but costs more to install and operate.

A unique type of blooming mill is now used in front

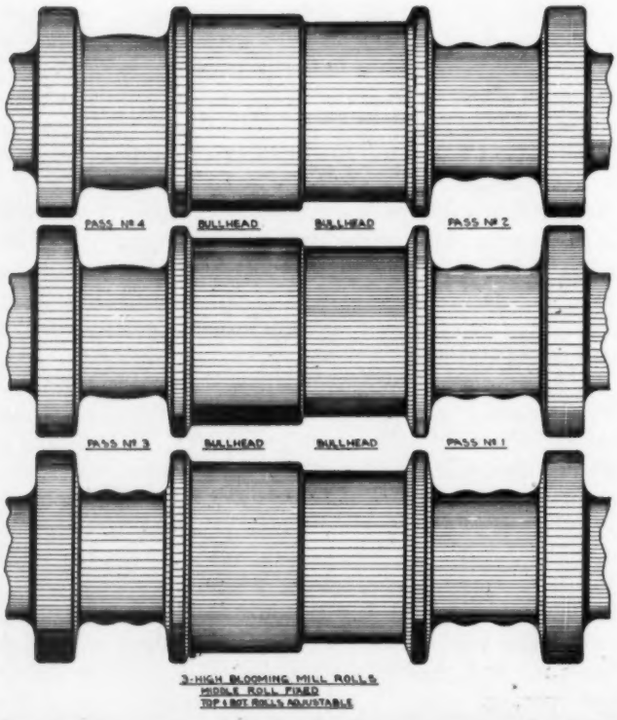
Presented before A. I. S. E. Chicago District Section Meeting, March 7, 1944.

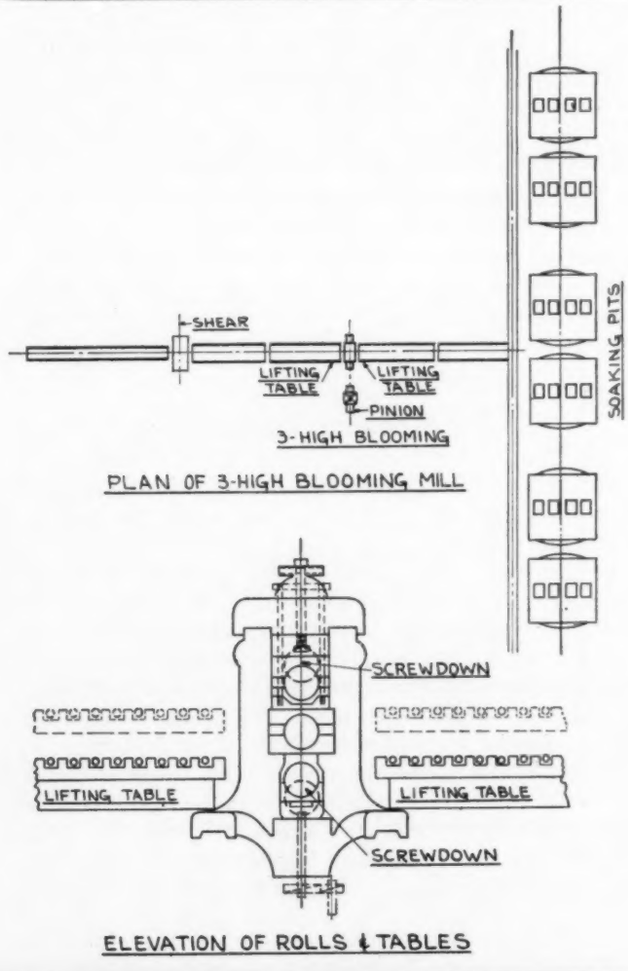



PASS No 8 TURN INTO 9
PASS No 6 TURN INTO 7
PASS No 4 TURN INTO 5
PASS No 2 TURN INTO 3
PASS No 9
PASS No 7
PASS No 5
PASS No 3
PASS No 1
3-HIGH BLOOMING ROLLS

Drawing 1 — Three-high blooming mill with fixed rolls.

Drawing 2 — Three-high blooming mill with adjustable top and bottom rolls.





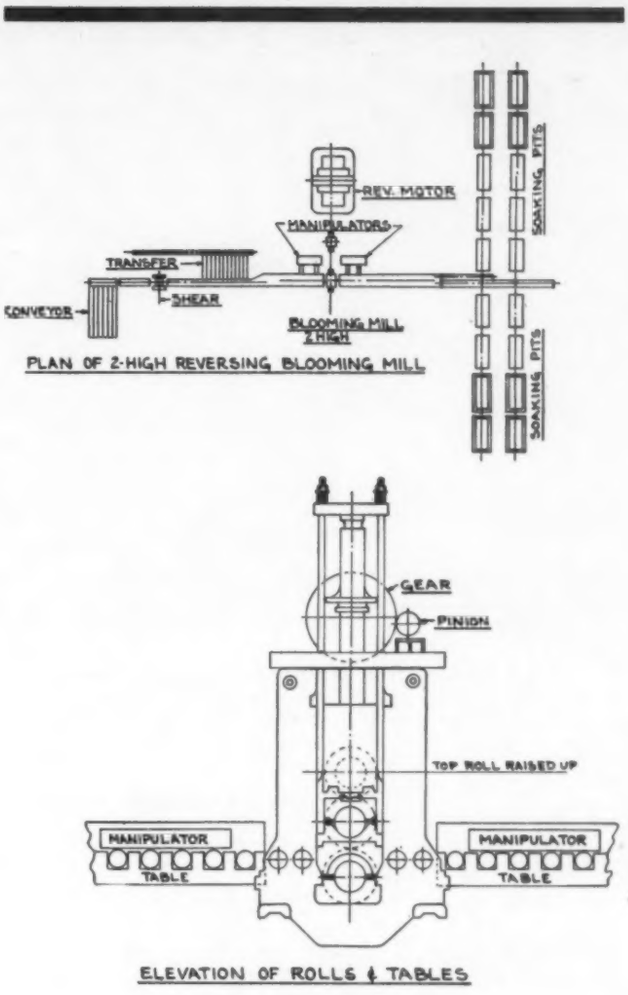
of a rail mill. Two tandem stands of two-high non-reversing mills are followed by a single three-high stand. The total of 11 passes in these three stands is taken as follows: The ingot is given one pass in the first tandem stand, turned 90 degrees and then sent through the second stand. It is then shunted around a turn table to the side of the mill, running on table rollers back to another turn table in front of the first stand. Here it is turned 90 degrees and given a pass in each of the two-high stands. The ingot then moves on to the three-high stand, where it is given seven passes before moving on to the rail mill. Drawing 4 illustrates the layout of this mill. In this layout it was thought that the surface and interior of the ingot would be improved by the gradual heavy draft possible with the large diameter, slow moving rolls, used for the first four passes. Two stands with the turn tables are equal to four stands in line, but cost less money and require less room than would four stands.

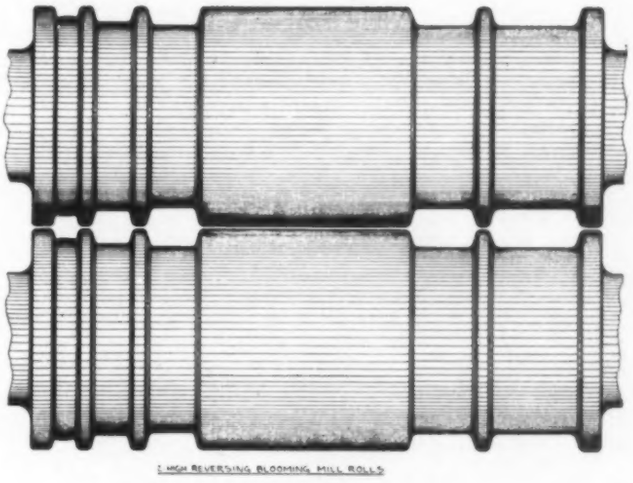
Another type of bloomer is the two-high reversing mill with a fairly long roll body. The driven end of the rolls is used to break down the ingot in the usual manner, using the screwdowns, after which the rolls are locked in position. The bar is then started through the first of a series of passes on the opposite end of the roll, using repeaters to take the bar around the end of the rolls. The repeaters are commonly known as the "merry-go-round" (see Drawing 5).

Another type of mill used is the tandem bloomer with as many as eight stands of two-high non-reversing mills in line. The rolls have grooved passes and the ingot receives one complete pass in each stand before entering the next stand. Mills of this type are high tonnage producers and there are several installations of the type in this country. Drawing 6 shows a mill of this type.

A rail mill bloomer roll design and mill sketch is shown in Drawing 7. The feature of the design is that grooved passes are used throughout, eliminating a plain bullhead. This is possible because only one ingot size is used and only a single bloom size rolled, drafts being based on the use of rail steel only. The grooved passes confine the piece on the corners and eliminate any danger of corner cracking.

The same general design can be used for the bloomer rolling a single size of ingot into a single size of bloom for a billet mill, with the exception that provision must be made for rolling a greater variety of steels.



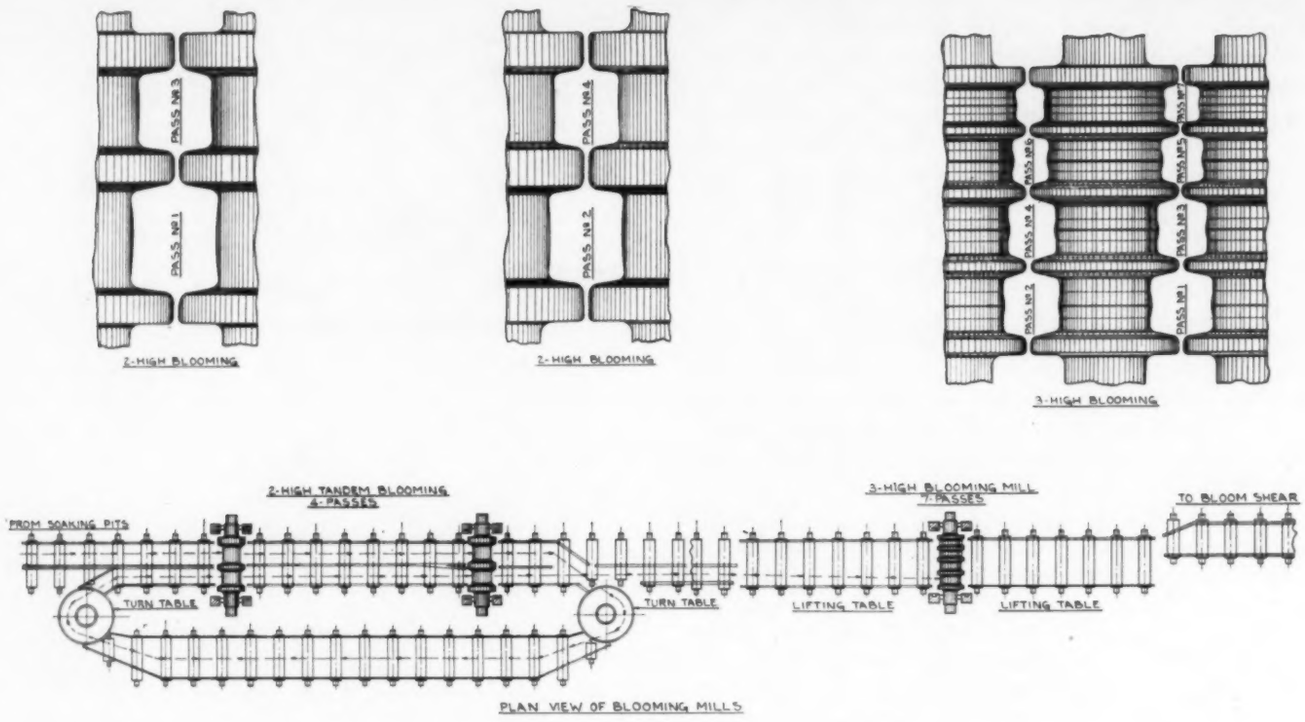


Drawing 3 — Two-high blooming mill.

BEAM BLANK ROLLS

A shaped bloom, called a beam blank, is required for the larger beams and certain channels finished in structural mills. In some cases a beam shaped ingot is used for the larger beam blanks made for universal beam mills, but for the smaller sizes to be rolled in either universal beam mills or standard structural mills, a square or rectangular shaped ingot is used.

Ordinarily, blooming rolls for beam blanks are turned with a bullhead pass, and edging pass, and one or possibly two beam blank passes. Usually there is not enough roll space available for an ideal arrangement of passes, and the best possible arrangement is made according to the space. The use of beam shaped ingots is based on the theory that there will be a more uniform distribution of draft during the rolling operation, that the flanges of the beam blank will be better filled, and that there will be less crop. In practice, the square or



Drawing 4 — Special blooming mill layout preceding a rail mill

rectangular ingot is broken down to a suitable size in the bullhead and then edged in the edging pass, where it is roughly shaped, and finally goes into the beam blank pass. After a few passes here it begins to overfill. The overfill is then rolled off, either in the edging pass or the bullhead according to size, and the piece finally is finished as a beam blank. A design for a medium size beam blank roll and the passes used, is shown in Drawing 8.

SLAB ROLLS

Slabs can be rolled faster in a slab mill equipped with plain horizontal rolls and vertical edging rolls than in a mill equipped with horizontal grooved rolls because no time is lost through turning the ingot on end to edge the width. A better surface, however, is obtained with grooved rolls as the edging and turning allow scrap and scale to fall off the piece when edged up. Any turning of the ingot on edge on a plain roll must be done in the early stages of breaking down. After this, the piece remains flat on the tables and scale is rolled in unless some means is provided to remove the scale. Another advantage of the horizontal grooved pass mill, is that edging passes are provided which confine the edge of the slab in a pass and prevent upsetting of the edge such as occurs on plain vertical edging rolls. Both types of rolls are illustrated in Drawing 9.

The size of the mill must be carefully considered when choosing the ingot sizes to be rolled, for it is obvious that a large ingot could not be rolled satisfactorily on a small mill.

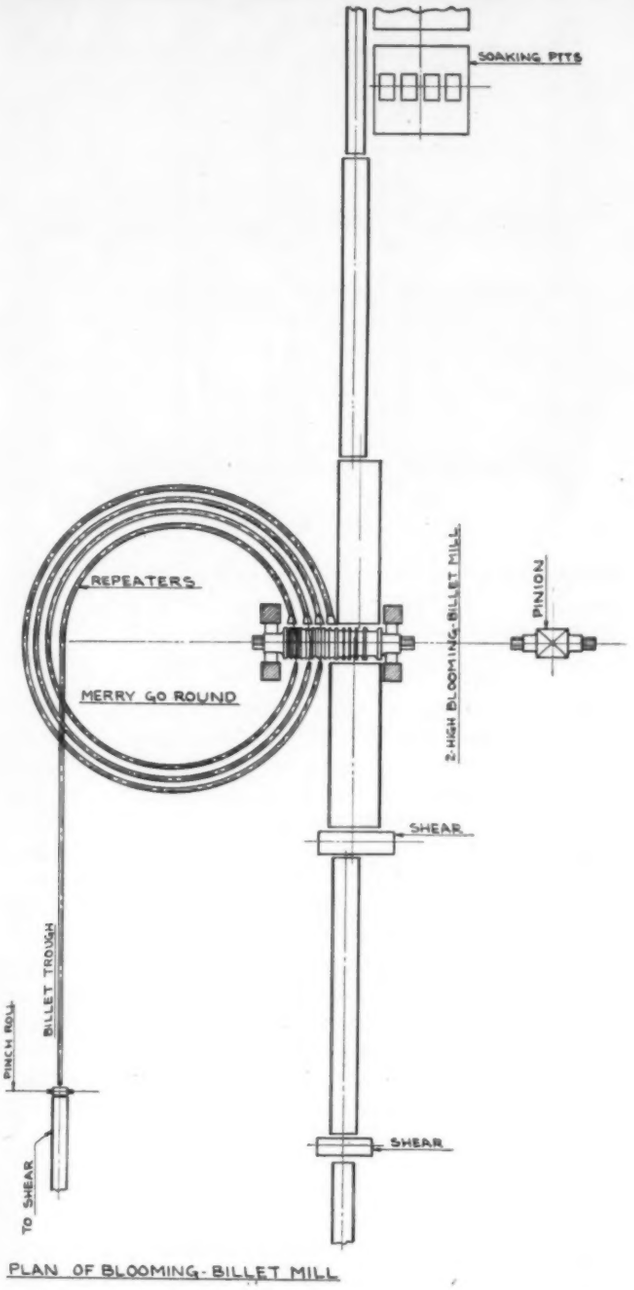
MILL SIZES

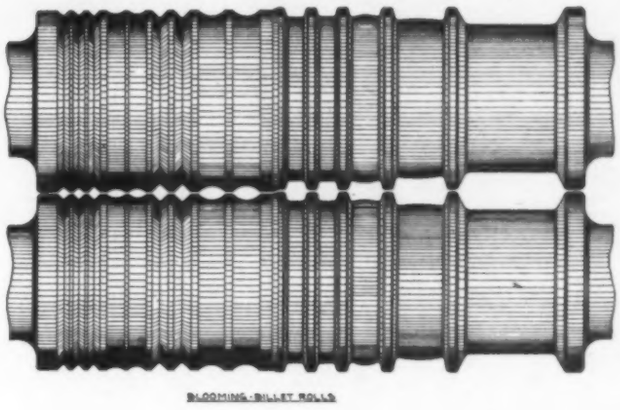
Blooming mills range in size from 18 in. to 54 in., the most popular sizes being 35 in. and 40 in. Roll diameter and length, together with the driving power, determine the maximum possible draft. However, in most cases it is not practical to use the maximum possible draft, as a moderate draft is more beneficial to the steel, depending to a large extent upon the analysis and heating of the ingot. A draft that could be used with good results on one grade of steel might be injurious to another grade.

When rolling an ingot in a flat pass, the initial drafts should be light until the ingot surface is well worked and the cross section reduced to a point where a heavier draft may be used without tearing the surface. In the grooved passes, the piece should not be subjected to drafts which will cause an overfill of the pass as this would result in a lap or seam when the piece is turned on its side for further reduction. Ingots which are cold on one side will camber in the rolls and it is difficult to avoid lapping the bar on one side when it is being edged if such a condition exists. Mills with side guard manipulation can correct this condition by straightening the bloom before rolling in a grooved pass. Mills with finger manipulation only are handicapped in this respect.

CALCULATION OF FORWARD SLIP

In determining the heaviest draft that may be taken on a plain slabbing surface of a bloom roll, it has been



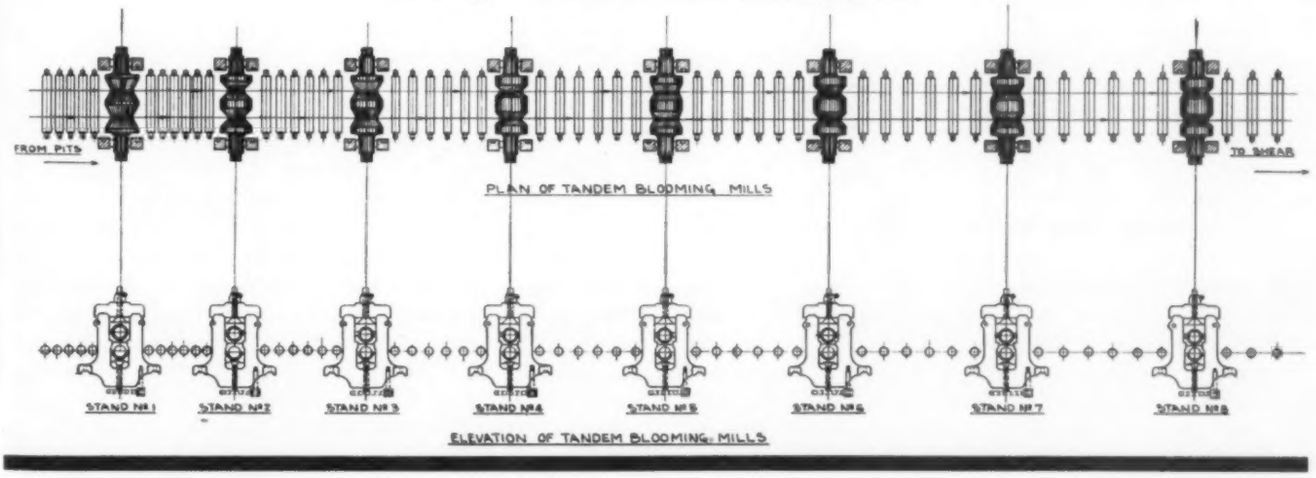


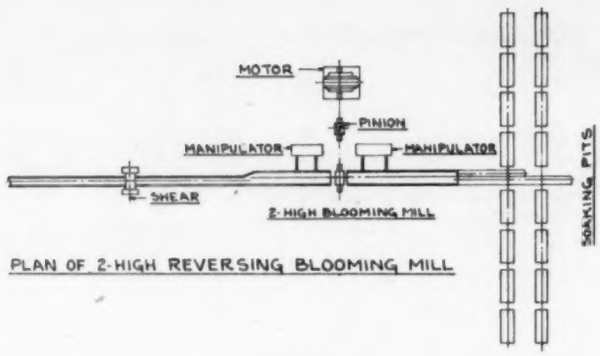
Drawing 5 — Two-high "ring-around-a-rosy" combination blooming and billet mill.

found by experiment that the angle of contact of the bar on the rolls may be as much as 30 degrees without ragging the rolls. This would vary with the grade of steel and the smoothness of the roll, but generally speaking, holds for ordinary steel and an alloy steel roll.

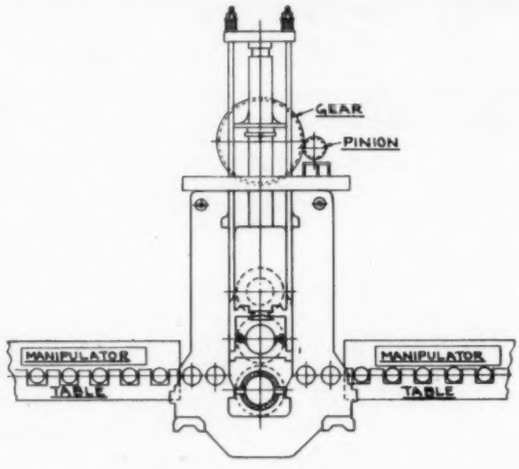
Drawing 10, used to illustrate the drafting on a pass in the blooming mill, shows a pair of rolls 32 in. in diameter. A draft of 3 in. is used as this gives even figures with which to work. A slab 11 in. thick by 15½ in. wide is rolled down to 8 in. x 16 in. in one pass. The drawing shows the entering and delivering speeds of the bar, and is also used to calculate the amount of forward slippage of the bar. The ratio of elongation of the bar, is the area of the entering section divided by the area of the delivered section, in this case 1.33 to 1. From these figures, and by referring to the drawing, it can readily be seen that the entering bar must travel slower than the roll surface at the point of roll entrance, and also that the surface speed of the bar must increase

Drawing 6 — Continuous tandem blooming mill.

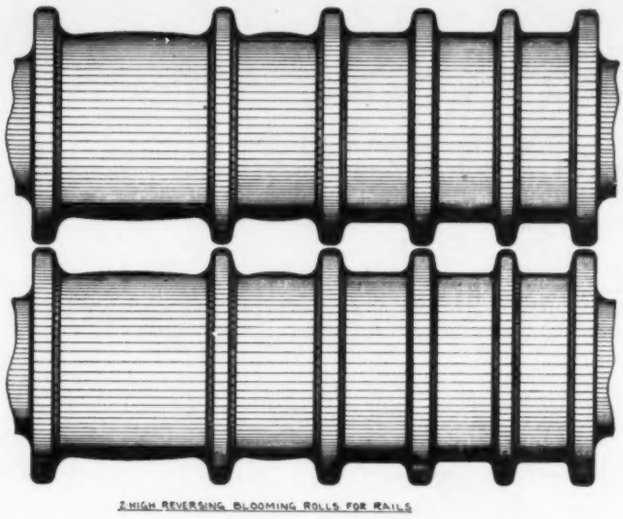




PLAN OF 2-HIGH REVERSING BLOOMING MILL



ELEVATION OF ROLLS & TABLES



2-HIGH REVERSING BLOOMING ROLLS FOR RAILS

Drawing 7 — Two-high blooming mill preceding a rail mill

to near the peripheral speed of the roll as it approaches the roll center. The delivery speed of the bar must be faster than the roll peripheral speed. Just where the bar surface speed equals the roll peripheral speed is not known exactly, but by experiment has been placed at the neutral point shown on the drawing. Thus in the illustration a bar entrance speed of 331.25 feet per minute will give a delivery speed of 427.26 feet per minute with a roll speed of 418.55 feet per minute.

From this it will be seen that the bar is slipping during its passage through the rolls, except at one point, and this is the cause of most roll wear. The effective use of water on the rolls, acting as a lubricant, will tend to minimize the wear.

Pins were driven through a test bar to show the speed of the surface of the bar leaving the rolls is greater than the speed of the center of the bar which is pulled along by the surface.

DEFECTS AND THEIR CORRECTIONS

A number of defects on blooms, billets and slabs can be caused by faulty mill practice. Some of this bad practice can be corrected by care in rolling. In the first stages of blooming an ingot a condition sometimes occurs such as is shown in Figure 1, Drawing 11. This involves an upsetting of the upper and lower parts of the ingot and is due to rolling pressure not penetrating to the center of the ingot. As the center of the ingot is not elongated by the rolling, the upper and lower surfaces are forced to upset and spread, any elongation of the center being caused by stretch. Close observation of the sides of an ingot subjected to this condition will show fine lines caused by the pulling or strain. An ingot bloomed down in a grooved pass would show a similar condition on the sides, but the corners would be confined and would not spread, with the result that there would be less danger of cracking on the corners. Figure 2 of Drawing 11 illustrates this condition. The best way to avoid damage to the ingot skin is by the use of light drafts, which cause less deformation, and by frequent turning. After an ingot has been considerably reduced in cross section, there is less damage from heavy drafting, with the result that drafts may be reasonably increased.

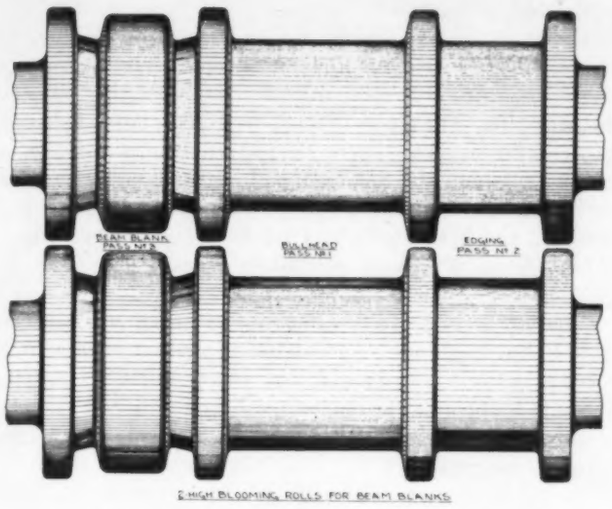
Another cause of surface defects is overfilling. This occurs in grooved passes and often causes laps as indicated in Figure 3, Drawing 11, resulting in rolled-in seams in the finished product. It is obvious that lighter drafts and more turns serve to remedy this trouble.

Figure 4 on Drawing 11 illustrates the condition that develops when a piece diamonds. When the bar is edged up in a grooved pass it will lean and over-fill and lap on opposite sides.

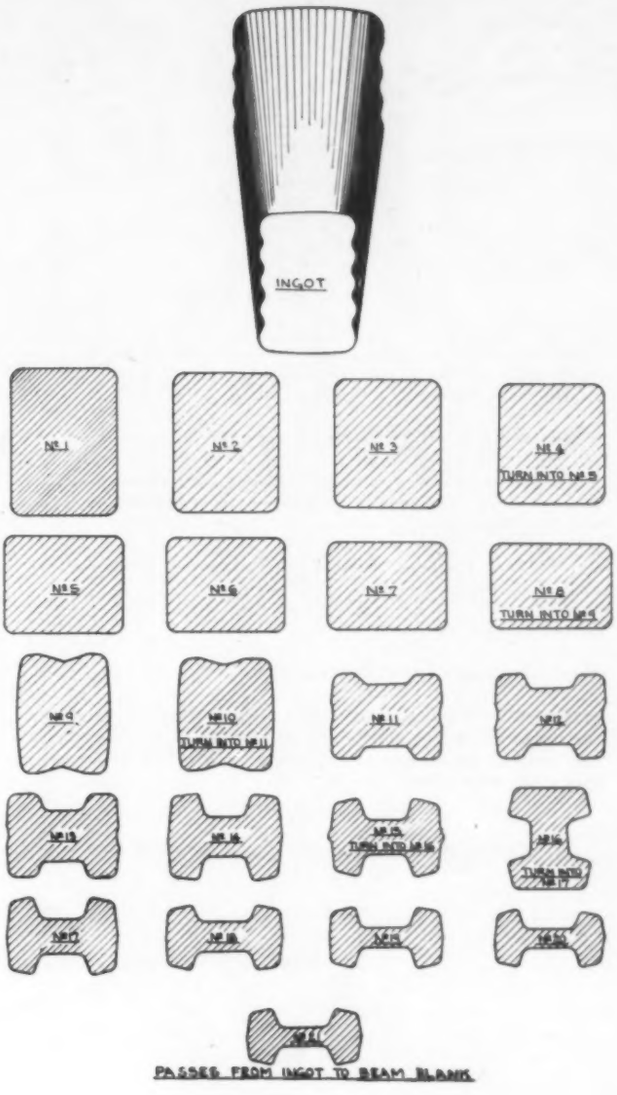
BLOOMING MILL ROLL PASSES

The design of roll passes for blooming mills is determined in a large measure by local conditions. Ingot sizes and range of product, together with the accuracy and quality in the sizes required are the determining factors. A bloomer which is required to roll a single size of ingot into only one size bloom would naturally have a different pass design from that used in a bloomer which is required to roll a variety of ingot sizes into a large number of bloom or slab sizes.

There are a number of standard size squares rolled in



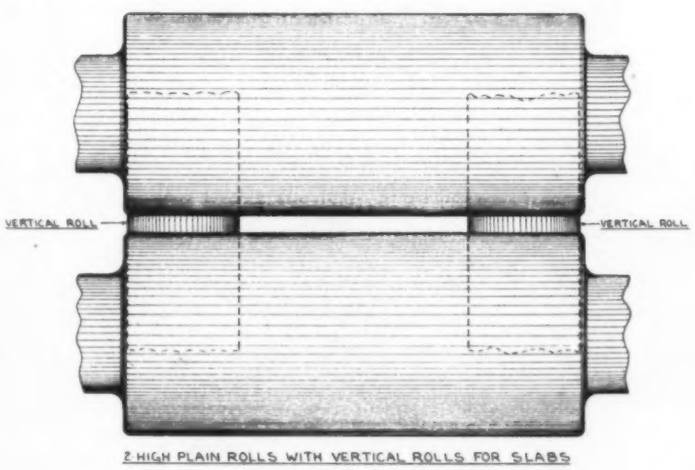
Drawing 8 — Rolls and passes for two-high blooming mill rolling beam blanks.

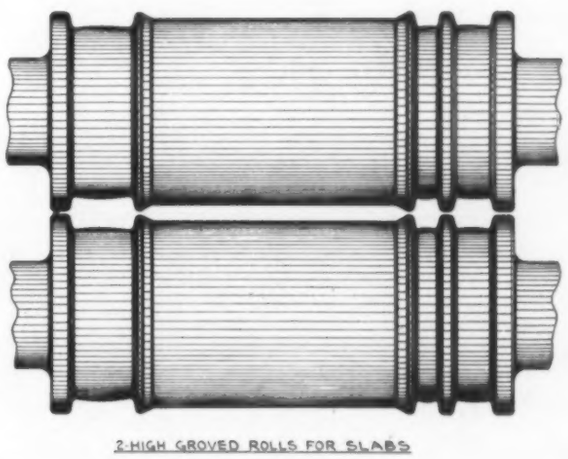


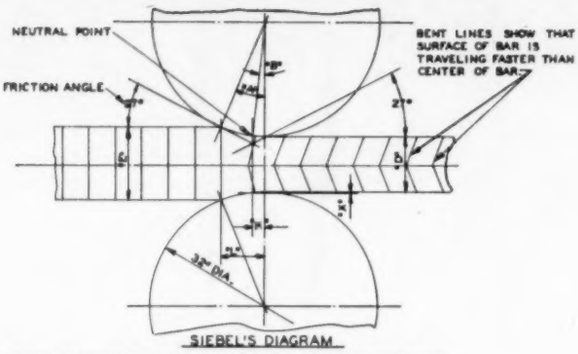
most bloomers. These are usually 4 in., 5 in., 6 in. and 8 in., and occasionally 10 in. The passes used to produce them are also used as edging passes for a large variety of slabs. Odd sizes are roughed out in the nearest standard size pass and finished on the bullhead.

Blooming rolls generally have a limited body length. As a result, it is difficult to arrange a series of passes which will finish the principal sizes wanted accurately, and at the same time put in enough grooves to work the ingot down most efficiently without over-drafting in any one pass. To solve this problem in the best manner, blooming rolls would have to be much longer than is practical. The first grooved pass is usually made as large as possible in the space available, so that the ingot will be put into a grooved pass as soon as possible.

Drawing 9 — Rolls for slabbing mills.






NEUTRAL POINT
FRICTION ANGLE
BENT LINES SHOW THAT SURFACE OF BAR IS TRAVELING FASTER THAN CENTER OF BAR
27°
SIEBEL'S DIAGRAM

FRICTION ANGLE = 27° ASSUMED ANGLE OF CONTACT - ENTERING POINT "A" = 29°
BAR ENTERING - "E" = 11" BAR DELIVERING - "D" = 8"
ALSO FROM SIEBEL'S DIAGRAM, K = 1.908" AND L = 8.781"

TO SOLVE FOR "X" $X = \left(\frac{E-D}{2}\right) \times \left(\frac{K}{L}\right)^3 = 1.5 \times .282^3 = .112"$

THICKNESS OF BAR AT NEUTRAL POINT = D + 2X = 8.00" + .224" = 8.224"
THE RATIO OF BAR THICKNESS AT NEUTRAL POINT AND AT DELIVERY POINT IS EQUAL TO $\frac{8.224}{8.000} = 1.028$

ALSO FROM SIEBEL'S DIAGRAM, THE ANGLE OF CONTACT "B" AT THE NEUTRAL POINT EQUALS 6°-48', THE COSINE OF WHICH EQUALS .99297

THE SPEED RATIO IS THEREFORE 1.028 X .99297 = 1.0208

FORWARD SLIP = 1.0208 − 1 = .0208 = 2.08 PERCENT

NOW AT 50 R.P.M. THE F.P.M. SPEED OF THE ROLL = 418.55. THEREFORE THE SPEED OF THE BAR DELIVERING = F.P.M. SPEED OF THE ROLL + AMOUNT OF FORWARD SLIP IN F.P.M.
F.P.M. INCREASE = 418.55 X .0208 = 8.71 THEREFORE DELIVERY SPEED OF BAR EQUALS 418.55 + 8.71 = 427.26 F.P.M.

Drawing 10 — Calculation of forward slip.

The advantage of working in a grooved pass is that the corners of the ingot are protected and the spread restricted to a certain degree.

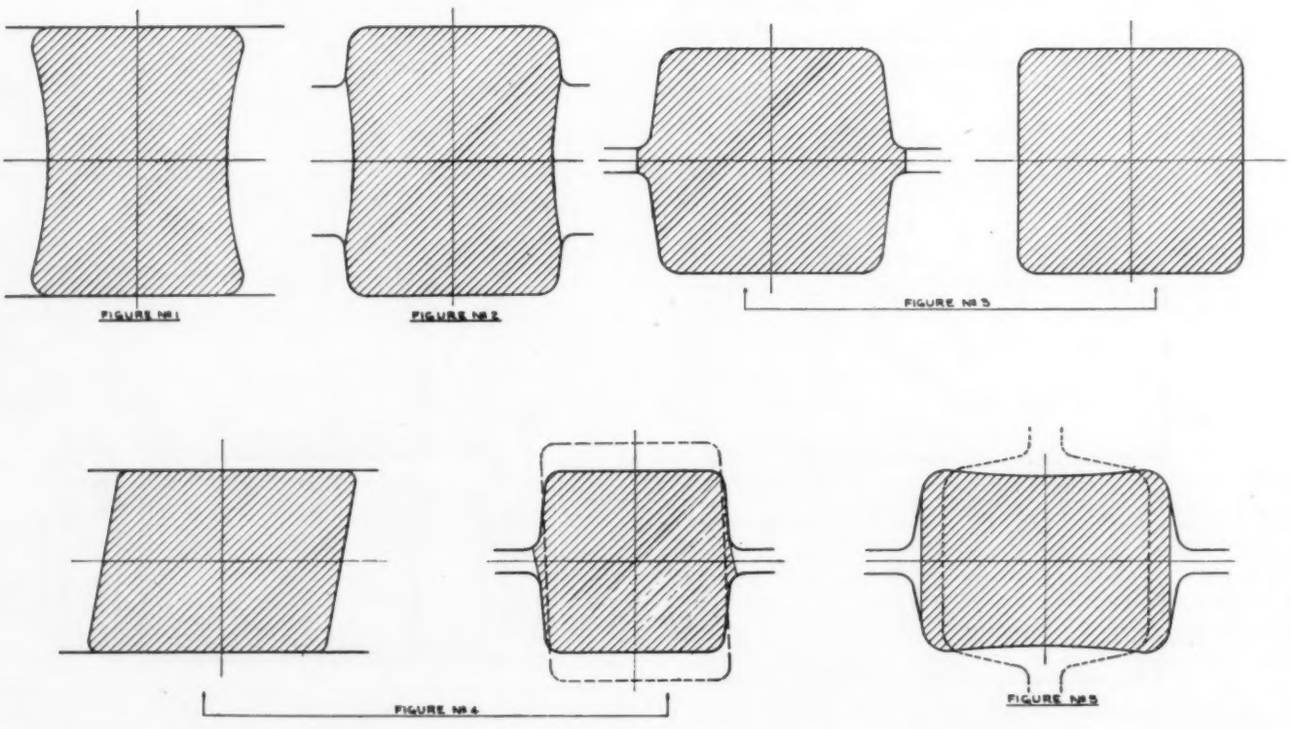
Grooved passes should be as deep as possible, as there will be less over-filling with any given draft, but there are limits to the depth which can be secured successfully. The pass cannot be lower than the mill table rolls, nor can there be too great a difference in height between the flat bullhead and the grooved pass. Furthermore, the use of too deeply grooved passes will weaken the roll. Collarless bullheads are used where thin slabs are produced, so that the rolls may be brought close together.

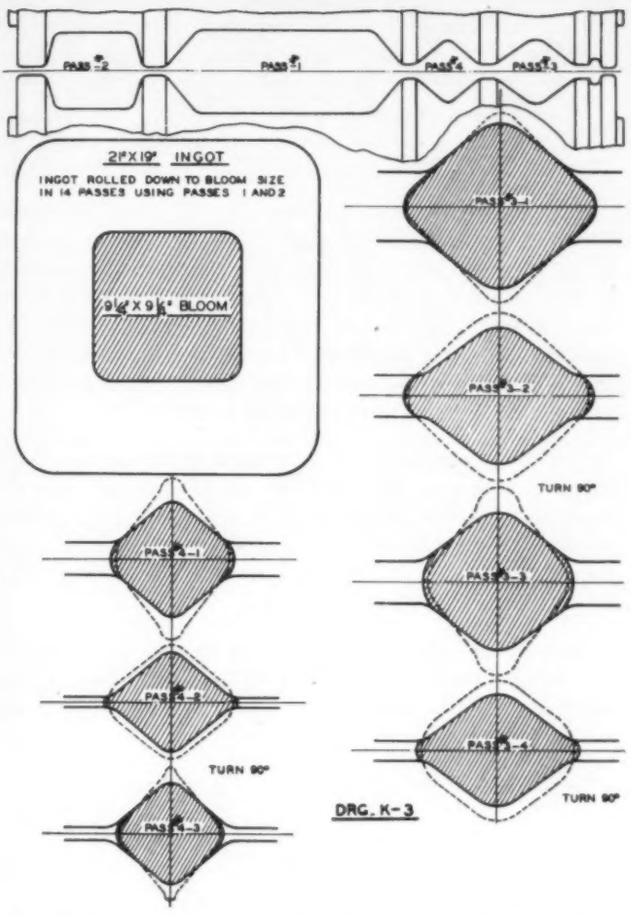
The angles of the sides of grooved passes are important. If the angle is too great the piece being rolled will have a tendency to turn down, whereas if the angle is too small, the amount of draft will be restricted and the rolls will cut badly on the sides and become too wide after a few dressings.

Swells in the grooves such as are shown in Figure 5 of Drawing 11 serve two purposes. One is that ragging, when used, will be placed to better advantage for gripping, and the second is that when a bar rolled with this swell in the pass is turned into the next groove, greater allowance is made for spread with less danger of overfilling. However, the same disadvantage is present as was mentioned before, in that there may be crimping on the sides when such a bar is edged. A flat bottom pass is preferable whenever possible.

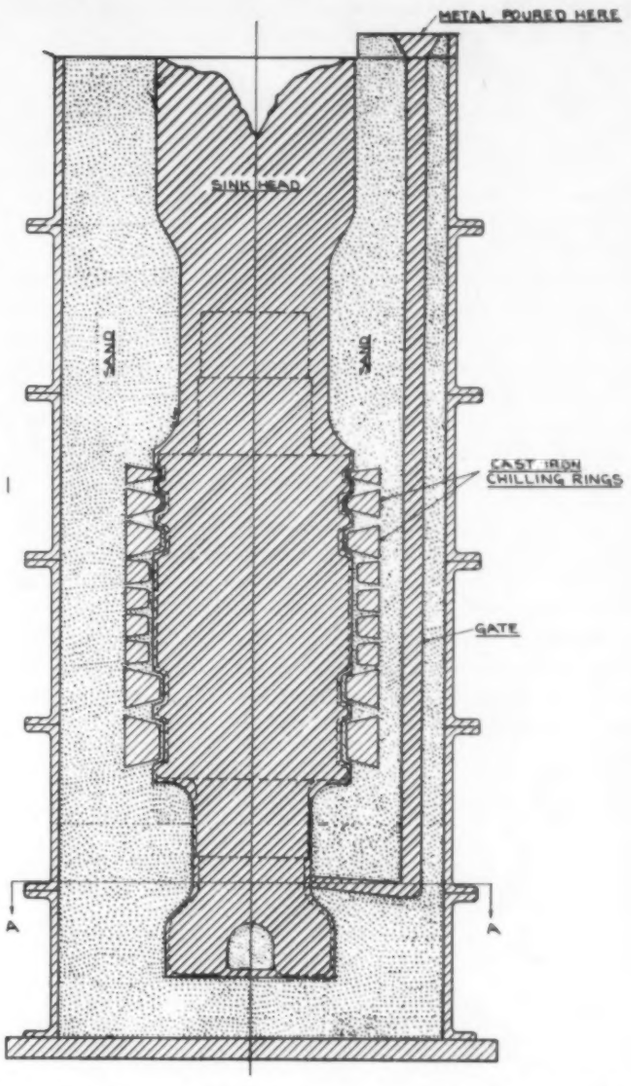
In the rolling of blooms and billets on two-high reversing blooming mills, it is the usual practice to break the ingot down on the bullhead pass, and then alternate between the various sized edging passes and

Drawing 11 — Defects arising from poor blooming mill practice.





Drawing 12 — Passes in a 35 in. blooming mill for 5¼ in. x 5¼ in. billets.



Drawing 13 — Method of casting an alloy steel roll for blooming mills.

the bullhead to reduce the ingot to the finished bloom or billet size. In this process, the piece is alternately flattened and edged, working on two sides at a time.

In doing this, there is considerable friction developed in the edging passes by the rubbing of the sides of the pass against the bar. That this friction is considerable may be shown by the fact that edging passes may be worn wide by as much as ¼ in. in one interval between dressings. This friction on the sides of the bars is not conducive to a smooth surface.

Diamond and square passes or open square passes by their slope confine the bars on all four sides and two corners in every pass. More reduction may also be made than in the flat and edge design.

One middle-western steel company has utilized both the flat and edge method and the diamond design in their blooming mill practice with considerable benefit to the steel. Drawing 12 shows the blooming rolls used and the passes for a 19 in. x 21 in. ingot rolled down to a 5¼ in. x 5¼ in. gothic square, having the approximate area of a 5 in. x 5 in. bloom, in 21 passes. This method includes grooved table rollers for the diamond passes and the use of side guard manipulation to turn the bars. The mill is equipped with a manipulator on the entering side only. If manipulators were located on both sides, two to four of the passes could be eliminated. The results of the use of this method of working are a better surface and less chipping expense.

BLOOMING MILL ROLLS

Blooming mill rolls are usually made of either carbon or alloy steel. The alloy steel roll is the more modern type, has greater strength and longer life, and gives a finer finish to the steel being rolled. Fire-cracking is also minimized when this type of roll is used. The alloying elements most commonly used in alloy steel blooming rolls are chromium, nickel, molybdenum, and sometimes vanadium. Each roll maker has his own formula for the roll analysis, but the skill of the roll maker in preparing molds, pouring the rolls, and heat treating them is fully as important as is the roll analysis. A common analysis for an alloy blooming roll is carbon .80/.90 per cent, manganese .70/.80 per cent, silicon .25/.30 per cent, phosphorus and sulphur .04 per cent maxi-

mum, chromium 1.00 per cent, molybdenum .25/.30 per cent. This is known as a "chrome-moly" roll. There are a large number of roll analyses with other alloys to suit different mill conditions.

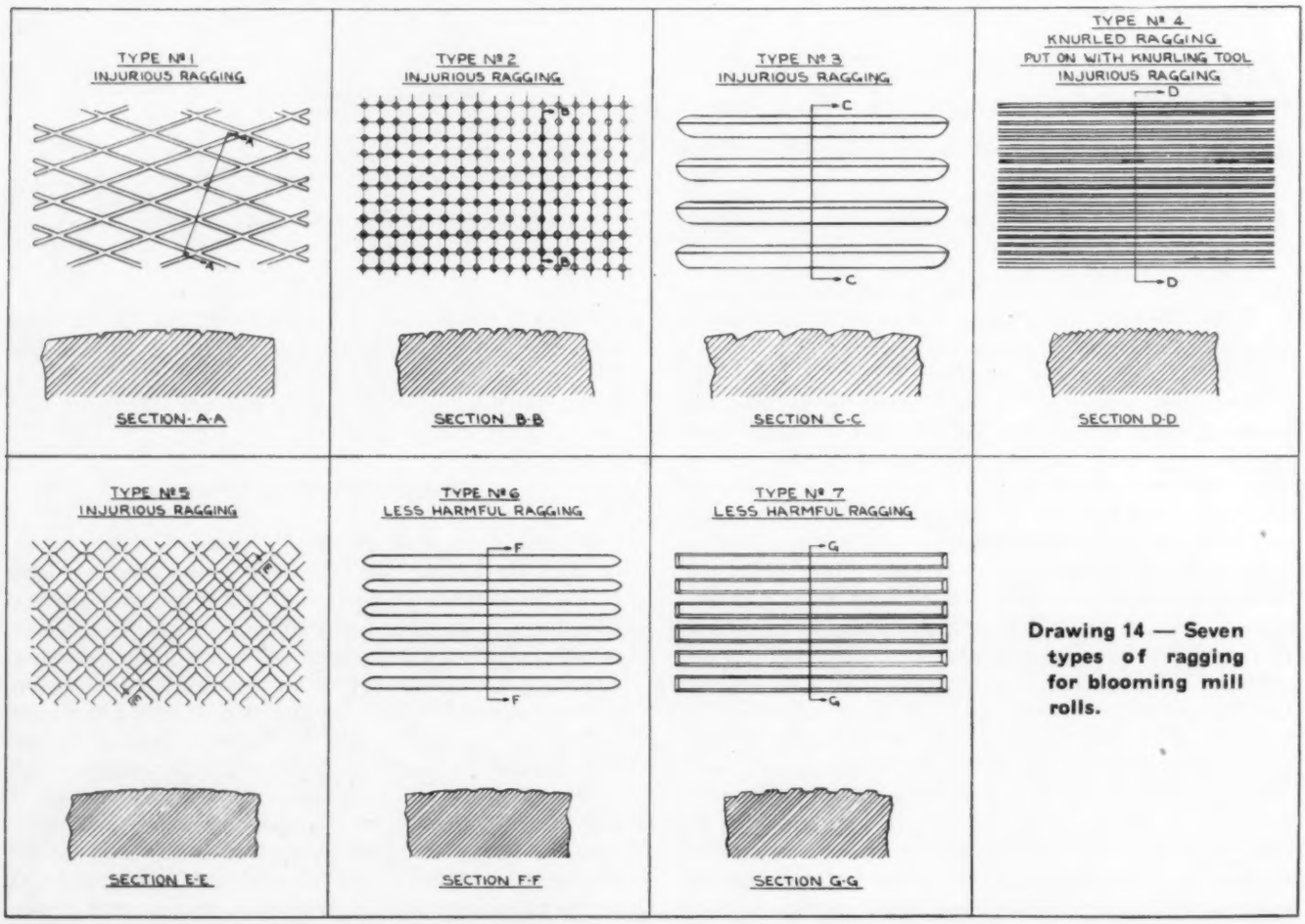
Heat treating of a blooming roll of the analysis given is done in approximately the following manner. The roll is shaken out of the mold and reaches the annealing furnace at about 1200 F. It is brought up slowly to about 1700 F and then allowed to cool to about 1000 F and then reheated to about 1550 F. At this point it is removed from the furnace and air cooled to about 1000 F, replaced in the furnace and brought back up to about 1250 F, after which it is allowed to cool down to about 300 F and finally removed from the furnace. This treatment varies with different types of rolls and requires a considerable length of time because of the mass of metal being treated and the necessity for raising or lowering the temperature gradually.

Drawing 13 shows a mold and blooming mill roll as cast. Chilling rings of cast iron are placed on practically the whole surface of the roll to chill the surface metal. This has the effect of making the metal harder and gives a better wearing and cleaner casting. The metal is poured from a ladle through a gate which enters the mold at an angle, giving a swirling motion to the metal as it rises to the top. This swirling brings dirt, sand, and other impurities to the outer surfaces where they can easily be removed to leave a clean casting. The dotted outlines of the drawing show the finished roll and the full lines the rough casting. The excess metal above is provided to avoid making pipe in the top end of the finished roll and is cut off before any turning work is done on the roll. Using this practice, roll foundries get about 55 per cent of good product from their total casting.

Ragging on blooming mill rolls is used to prevent slippage while using heavy drafts. Unless the ragging is very shallow and parallel to the axis of the rolls, it may be very injurious to the steel, causing slivers and laps. Inverted ragging is used on a few mills, this ragging protruding from the roll in contrast to the usual type of ragging which is sunk into the roll.

Generally speaking, the less ragging the better. High sulphur bessemer steel when rolled very hot will invariably slip even when the rolls are ragged if a heavy draft is used. Drawing 14 illustrates several types of ragging. Types 1, 2, 3, 4 and 5 are injurious to the steel. Types 6 and 7 are less injurious.

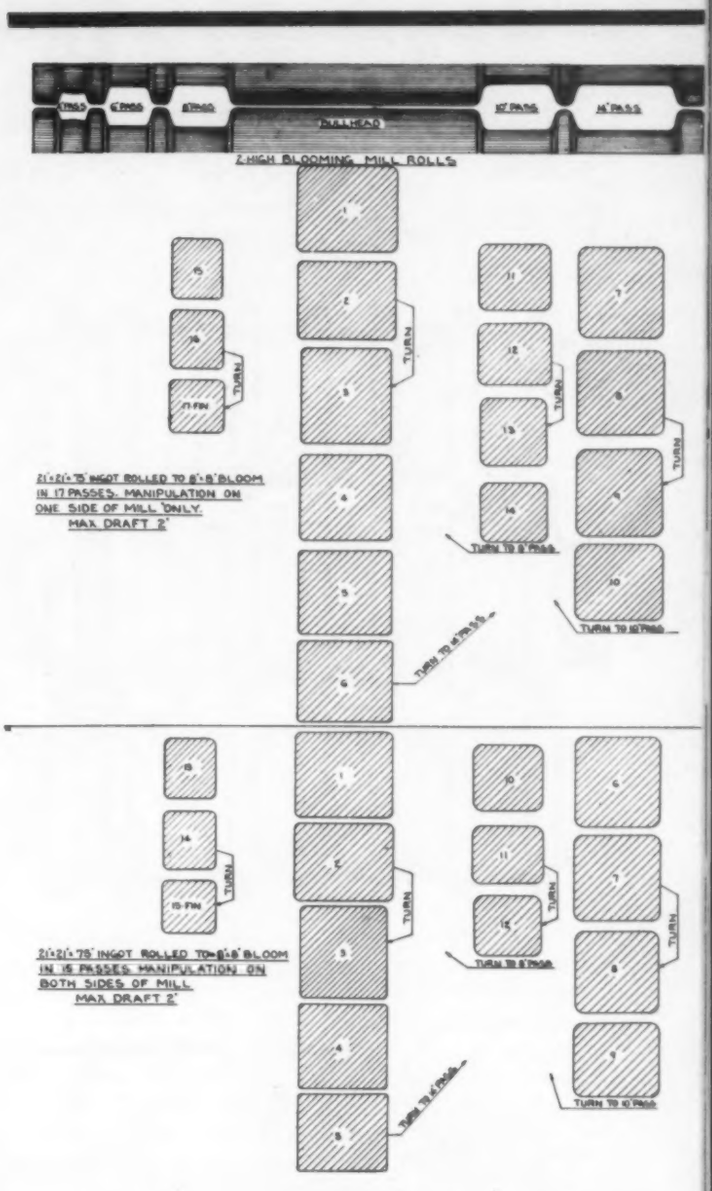
The passes shown on the top half of Drawing 15 are designed to roll a 21 in. x 21 in. x 75 in. ingot into an 8 in. x 8 in. bloom in 17 passes. Side guards are



Drawing 14 — Seven types of ragging for blooming mill rolls.

provided on both sides of the mill, but the finger manipulator is on the pit or front side of the mill only. Turning is done only on the front side of the mill. The rolls have a flat bullhead and 14 in., 10 in., 8 in. and 4 in. passes. Collar diameter of the rolls is 37½ in. The ingot is rolled small end first. Two passes are given on the bullhead at approximately 2 in. draft each, the ingot turned and given four passes at 1½ in. each, then turned into the 14 in. pass. Two passes are then given at approximately 2 in. each and the piece turned and put back again in the 14 in. pass. Two more passes are given and the piece turned and put into the 10 in. pass, where it is given two passes at 2 in. each, turned and given two more passes in the same pass at 1 in. each. The ingot is then turned and put into the 8 in. pass, where it is given two 1 in. passes before being turned and finished either in the 8 in. pass or on the bullhead. It is somewhat quicker to finish on the bullhead, as the rolls will be about 8 in. apart and it will not take long to get the top roll up in position for the next ingot. Finger and side guard manipulation on both sides of this mill would reduce the number of passes required.

The 21 in. x 21 in. x 75 in. ingot can be rolled in two less passes when turned on both sides of the mill. These 15 passes are shown at the bottom of Drawing 15 below the 17 pass schedule. The maximum draft used is 2 in. and the last three passes are exactly the same as in the 17 pass schedule, the final bloom being as accurate in dimensions as in the longer schedule.


2 HIGH BLOOMING MILL ROLLS
BULLHEAD
TURN
21"x21"x75" INGOT ROLLED TO 8"x8" BLOOM IN 17 PASSES. MANIPULATION ON ONE SIDE OF MILL ONLY. MAX. DRAFT 2"
21"x21"x75" INGOT ROLLED TO 8"x8" BLOOM IN 15 PASSES. MANIPULATION ON BOTH SIDES OF MILL. MAX. DRAFT 2"

Drawing 15 — Two pass schedules for rolling 21 in. x 21 in. ingots to 8 in. x 8 in. blooms.

COOLING WATER

Cooling water should be carefully applied to blooming mill rolls, used in liberal supply, and evenly distributed over the rolls. The rolls should always be warm if possible, never chilled. When an ingot is rolled on cold rolls, the sudden application of the hot ingot to the chilled roll surface will cause a quick expansion of the roll and cracks will develop. When the mill is not rolling the water should be off. However, if the water is on while the mill is down, the rolls should be kept turning to avoid cooling one part of the roll more than another as uneven cooling is one of the most frequent causes of roll cracks.

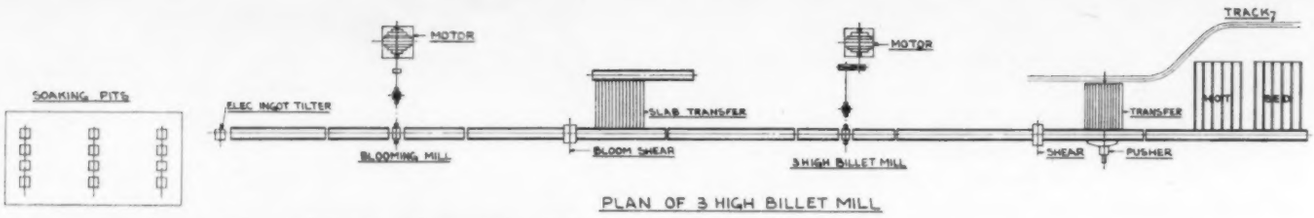
In some mills great care is given to having the rolls warmed up before being used in the mill. In one case a pit is provided where rolls can be heated with steam coils before being put into the mill. This practice minimizes fire cracking and roll breakage. Rolling without water on the rolls and then putting the water on the heated rolls will also cause cracking.

BILLET AND SHEET BAR MILLS

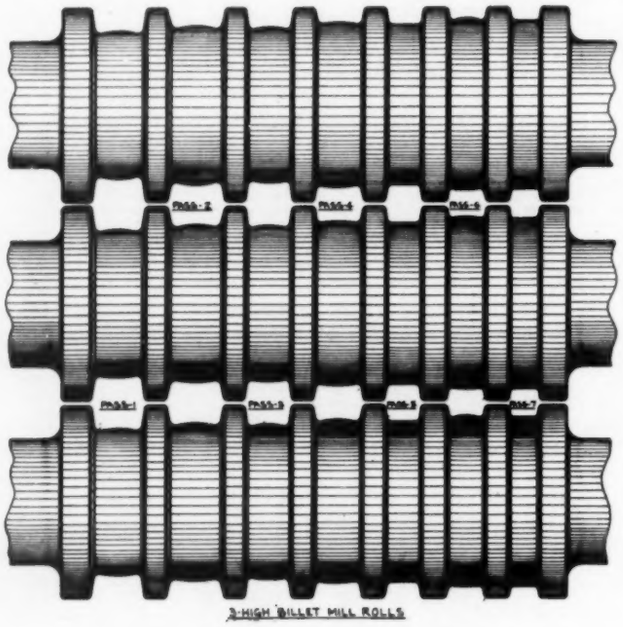
Attempting to use a blooming mill to roll billets and slabs of comparatively small size results in slow operation and inaccuracy in size of the product. A mill following the blooming mill and fed with steel from it is known as a billet mill or sheet bar mill. Such a mill is also used at times to roll light slabs. The purpose of this second mill is to relieve the blooming mill of the necessity of rolling the smaller sizes which slow it down. By using the two mills together it is possible to roll smaller sizes than can be rolled on the bloomer alone and thereby greatly increase the tonnage and improve the quality of the product, while at the same time reducing operating costs.

Billet and sheet bar mills may be of several types. One of these is the single or double stand three-high mill with lifting or tilting tables. Such a mill will take an 8 in. x 8 in. or 6 in. x 6 in. or similar size bloom and in a series of passes reduce the piece to a 4 in. x 4 in. or 3 in. x 3 in. billet. A plan of such a mill and a sketch of the rolls is shown on Drawing 16. The rolls take an 8 in. x 7 in. bloom and in seven passes reduce it to a 4 in. x 4 in. billet.

When an ingot is rolled on the blooming mill for such a billet mill it must be cut into two or three lengths to make it suitable for handling. The 8 in. x 7 in. bloom rolled from the ingot could not be rolled in the billet



PLAN OF 3 HIGH BILLET MILL



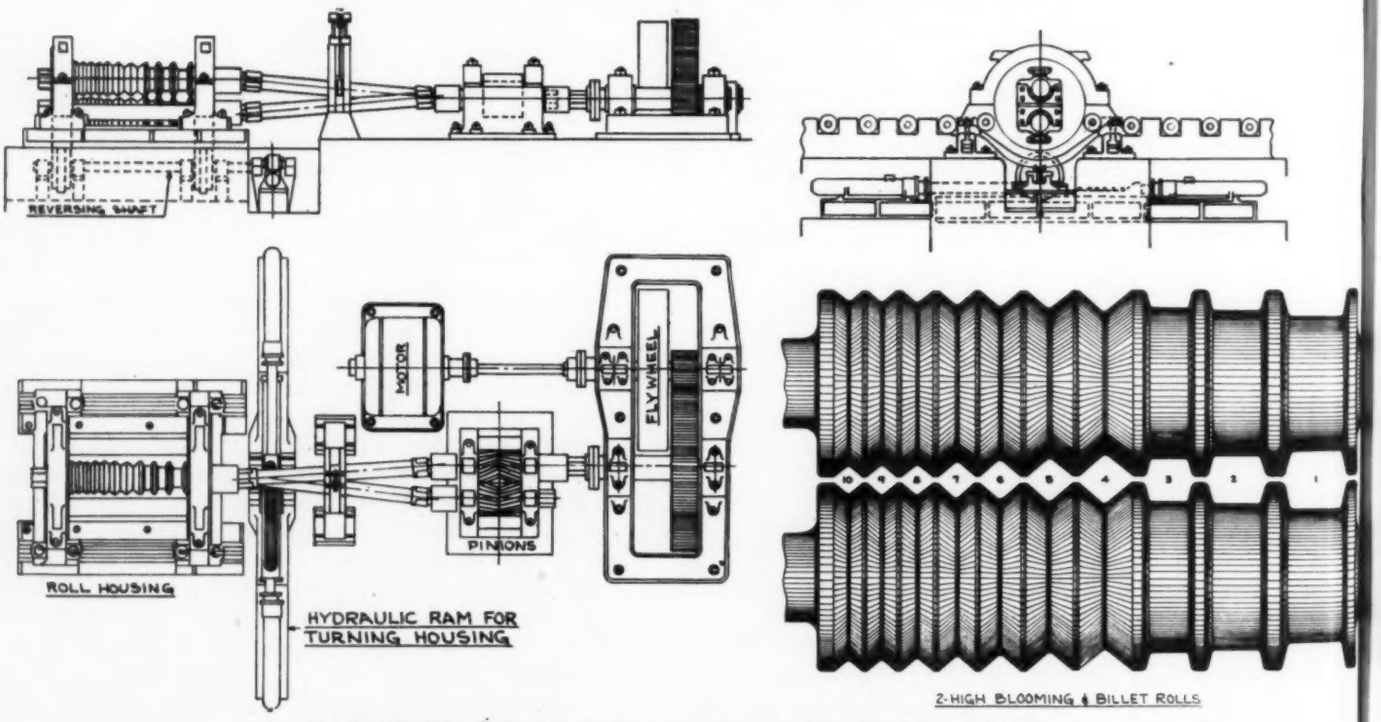
3-HIGH BILLET MILL ROLLS

Drawing 16 — Mill layout and rolls for three-high billet mill.

mill in one piece as it would be too long to handle on the billet mill tables.

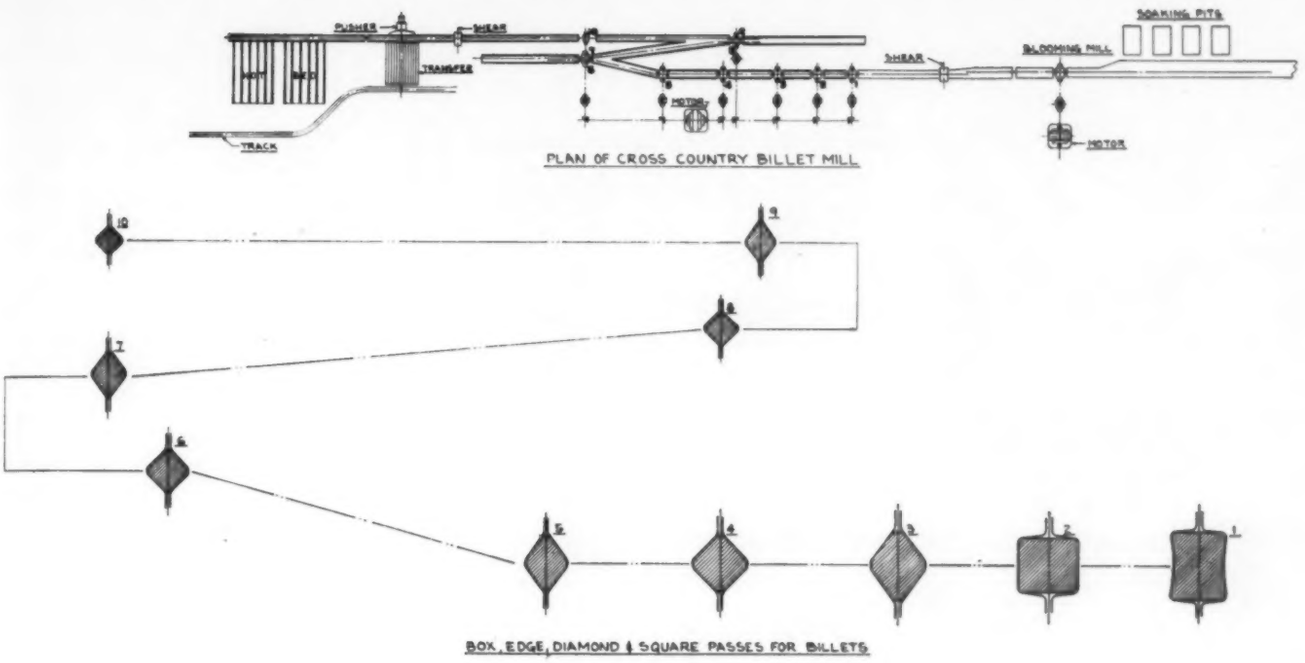
Cutting the bloom into two or three lengths means that the pieces must be rolled at different temperatures, the last pieces being rolled at lower temperatures than the first. This results in considerable variation in the cross section of the bar between the first and last cuts rolled. This disadvantage may be offset to a certain degree by a good billet mill table arrangement, allowing more than one bar to be in the rolls at the same time. Thus when the first piece is going through the finishing pass, the second bar is being rolled through one of the earlier passes and the third piece about to enter the rolls. This procedure speeds up rolling and also increases the tonnage rolled in the mill.

Drawing 17 — Mill arrangement and rolls for a two-high Lamberton mill.



2-HIGH BLOOMING & BILLET ROLLS

ELEVATION & PLAN VIEW OF BLOOMING-BILLET MILL



Drawing 18 — Cross-country billet mill.

The Lamberton mill, rolling billets, rounds, and squares, represents an ingenious idea and is shown in Drawing 17. This mill is a two-high unit with the motor turning in one direction only, the roll housing having two horizontal rolls in the usual position, but the mill pinions are placed in the same horizontal plane. The mill housing revolves back and forth through 180 degrees so that the rolls exchange positions after each pass, thus reversing the rolling direction. The bottom roll becomes the top and the top the bottom, the bars being rolled in either direction without reversing the motor. The principal idea in this design was to avoid the cost of a reversing motor.

Another type of mill is known as the cross-country design. In this layout the piece as rolled in the bloomer is cut into two or three lengths and rolled in a series of roll stands with the passes distributed to the best advantage in the various stands. There may be more than one pass in each stand, or in some of the more elaborate mills there may be only a single pass in each stand. Such a mill is faster than the ones previously described, but is still open to the criticism that the piece from the bloomer must be divided into a number of cuts so that the last piece finishes colder than the first. Also, this practice results in a relatively low percentage of product from each cut as the product must be cropped front and back. A plan of such a mill and of passes for billets and sheet bars is shown on Drawing 18.

A more efficient type of mill is the continuous mill with several stands in line. In many cases the whole ingot, after being rolled in the blooming mill, may be rolled as a single piece through such a billet mill. This type of mill can produce a very uniform billet or bar at a low cost.

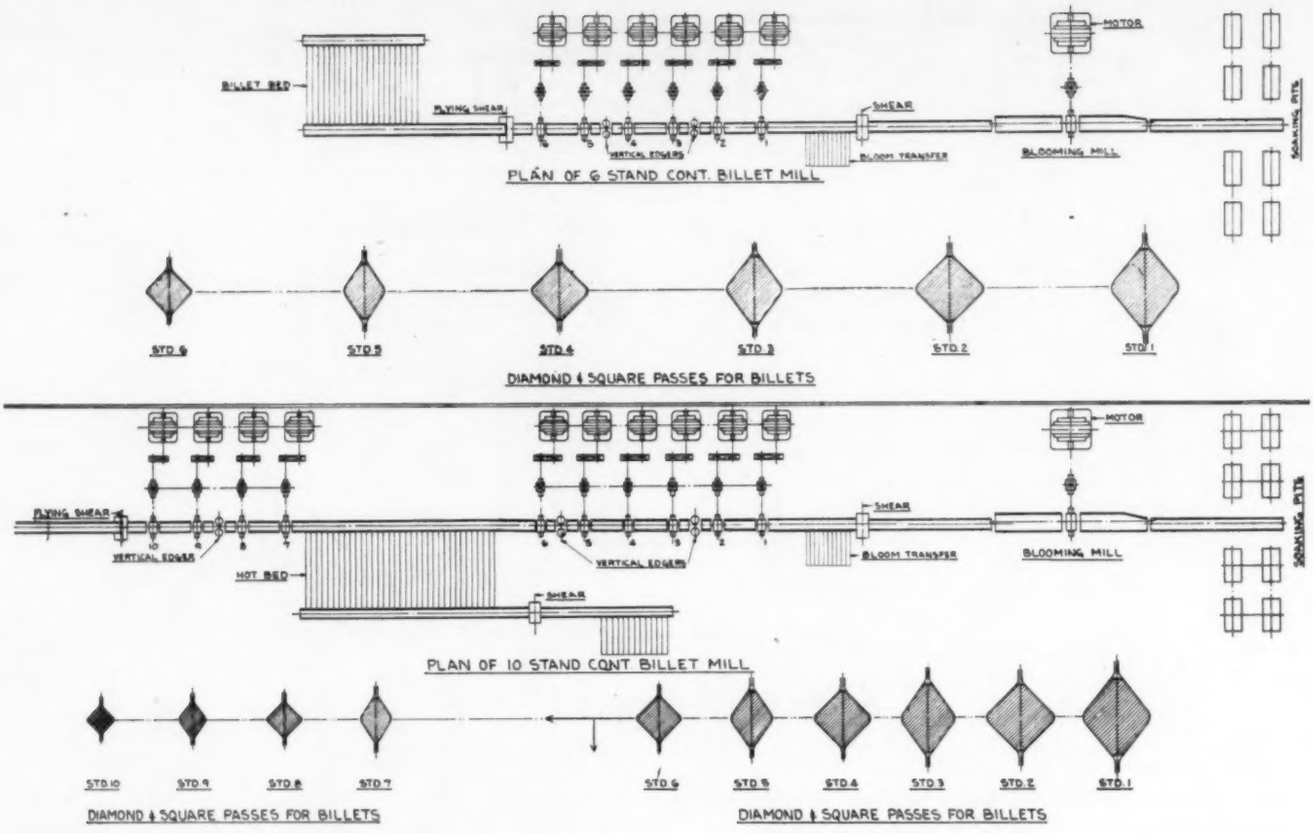
Continuous mills rolling small sizes have a flying shear after the last roll stand, synchronized with the finishing stand speed to cut the bar into suitable lengths. Thus the product of one ingot, which if delivered in one long piece from the finishing stand would be in some cases hundreds of feet long, is by the use of the flying shear cut into bars 20 to 30 feet long as fast as it is delivered from the mill. A plan of such a mill and of typical passes used for billets is shown on the upper part of Drawing 19.

The lower half of Drawing 19 shows a still more efficient billet or sheet bar mill, and one on which the smaller slab sizes may also be made, having two separate groups of continuous mills where the bar is rolled completely out of the first group before entering the second group of roll stands.

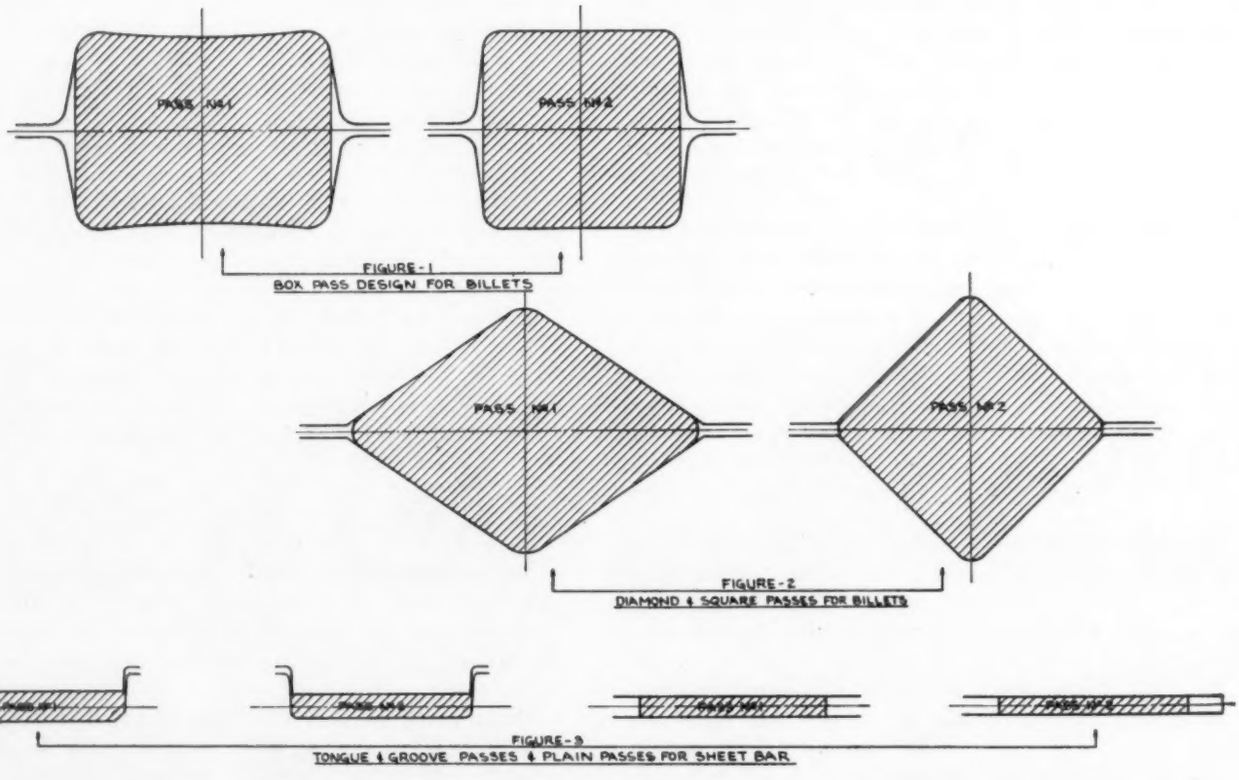
In this layout there are two outlets for the product. In the first group of roll stands the bloom as received from the bloomer is rolled into the larger size billets, 3 in. x 3 in. and up to 6 in. x 6 in. These are rolled in such lengths that they may be pushed sideways, after leaving the first group of roll stands, onto a hot bed where they are cut hot into any lengths desired. The cuts may vary from 3 ft to 30 ft. The shorter lengths could not be cut on a flying shear direct from the mill.

When both groups of mills are used for rolling sizes below 3 in. x 3 in. and for sheet bar, the piece as finished from the first group of roll stands is further reduced in the second group of rolls and cut into lengths by a flying shear.

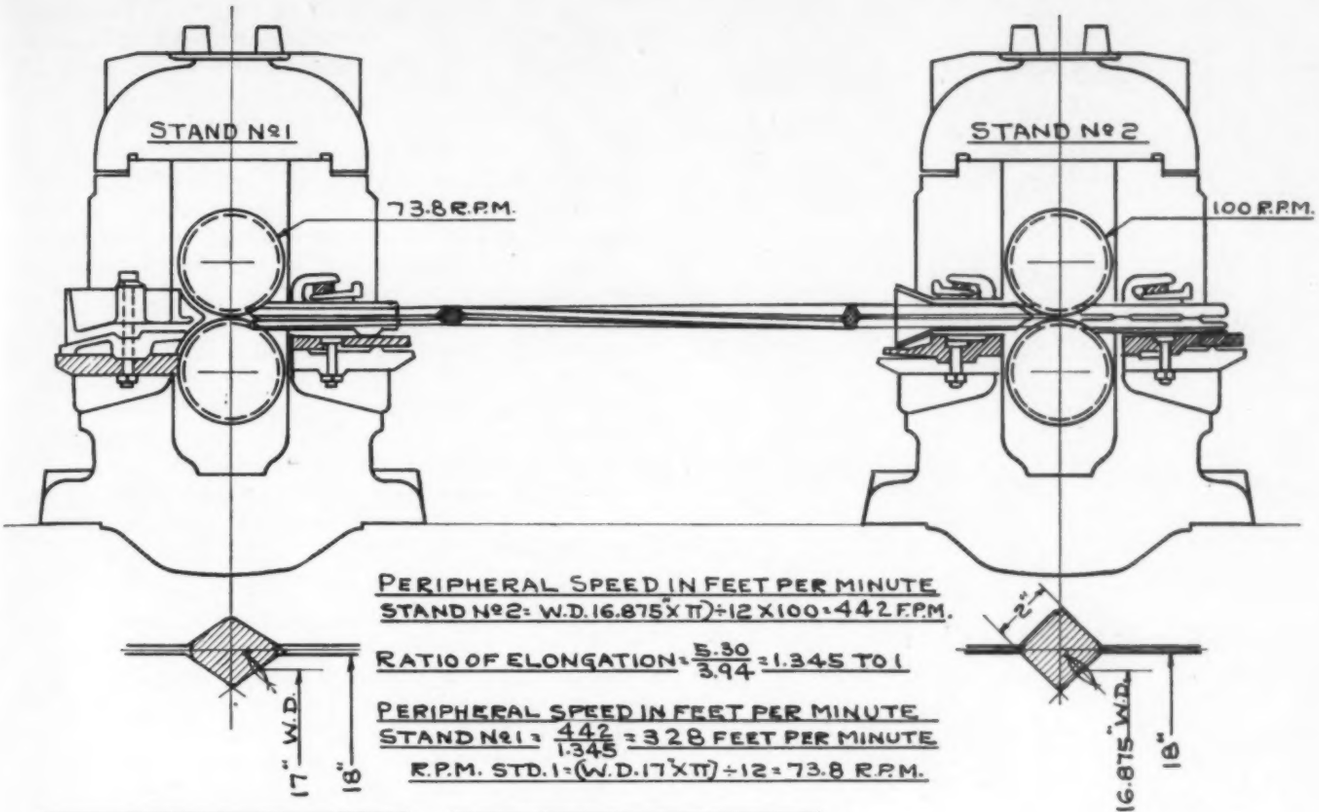
When slabs are rolled in mills of this type they are usually finished on the first group of rolls. In such a layout, vertical edging rolls are used to regulate the width of the piece and to give a good square edge. By the use of the vertical rolls, slabs of various widths



Drawing 19 — Two types of continuous billet mills.



Drawing 20 — Passes for billets and sheet bar.


STAND Nº1
73.8 R.P.M.
STAND Nº2
100 R.P.M.
PERIPHERAL SPEED IN FEET PER MINUTE
STAND Nº2 = W.D. 16.875" × π) ÷ 12 × 100 = 442 F.P.M.
RATIO OF ELONGATION = 5.30 / 3.94 = 1.345 TO 1
PERIPHERAL SPEED IN FEET PER MINUTE
STAND Nº1 = 442 / 1.345 = 328 FEET PER MINUTE
R.P.M. STD. 1 = (W.D. 17" × π) ÷ 12 = 73.8 R.P.M.
17" W.D.
18"
2"
16.875" W.D.
18"

STAND Nº1	
ROLL DIA.	18"
SPEED	73.8 R.P.M.
WORKING DIA.	17"
FT. PR. MIN.	328 FT.
AREA	5.30 sq. in.

STAND Nº2	
ROLL DIA.	18"
SPEED	100 R.P.M.
WORKING DIA.	16.875"
FT. PR. MIN.	442 FT.
AREA	3.94 sq. in.

Drawing 21 — Calculation of relative speeds and section areas in continuous mill.

may be rolled on the same plain roll pass by merely changing the distance between the edging rolls and starting with a suitably sized piece from the blooming mill.

Sheet bar would be finished in the second group of stands, which also has vertical roll stands to regulate the width of the bar. The sheet bar is cut to length by the flying shear and piled in a bar piler as fast as rolled.

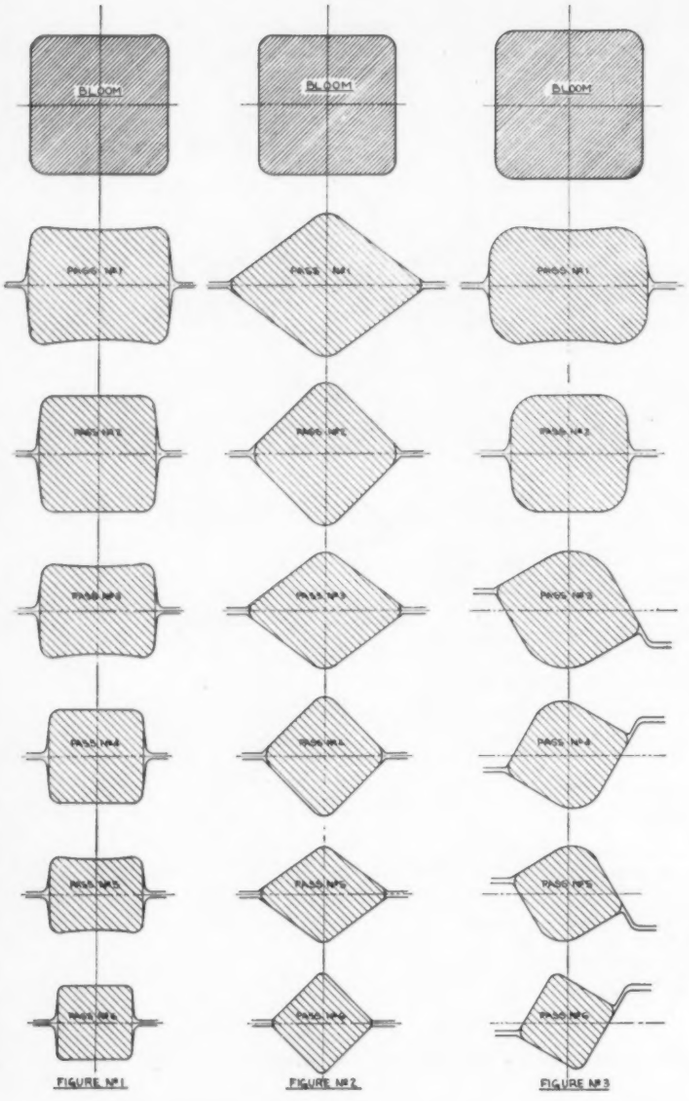
This last type of mill is very efficient. It can roll a wide variety of billet sizes from a large bloom size and can consistently turn out good tonnage. The bloomer would be rolling practically all the time except for roll changes. While large blooms and slabs are being taken off the bloomer, any necessary roll changes and pass adjustments can be made in the billet mills, making the arrangement very flexible and efficient.

One of the greatest advantages offered by these billet mills is that the ingots may be rolled direct into billets, sheet bars, or slabs from the initial heat and without loss from furnace scale or cropping such as would be inevitable if reheating furnaces were used between the blooming and billet mills.

ROLL DESIGN FOR SECONDARY MILLS

Roll design for billet, sheet bar and small slab mills presents some unique problems. In the three-high billet mill first described, the billets are usually rolled by the so-called box pass design, although in a few instances the diamond and square design may be used. Figures 1 and 2, Drawing 20 illustrate these passes. Sheet bar, if rolled on a mill of this type, would be rolled by a combination of box passes, tongue and groove passes and plain roll passes as shown in Figure 3, Drawing 20. Slabs are not usually rolled on a mill of this kind, but when they are, the rolling is done by a combination of the box pass and the plain and edge pass methods.

Cross country type mills have billet passes of box and edge, diamond and square, or a combination of both as shown in Figures 1 and 2, Drawing 20. Sheet bar, if rolled, would be made in flat passes with several vertical rolls used as edging passes. Hydraulic sprays are used to remove scale from sheet bar, and the last few passes are made in plain chilled rolls to assure a smooth finish.



Drawing 22 — Various pass designs for rolling billets.

The third type of mill described would have either box or edge passes in the earlier stands or diamond and square, and in the smaller passes, diamond and square for the billets. Slabs would be made in plain flat passes with several stands of vertical rolls to square the edges and confine the width. All widths and thicknesses would be made on the same passes.

The continuous mill has another roll designing problem in that the piece rolled is in more than one set of rolls at the same time. This means that roll speeds and roll diameters must be so designed that the elongation of the bar resulting from the reduction in area effected by each pass is compensated for by progressively increasing the peripheral speed of the roll stands. Drawing 21 shows a diamond in one stand of a continuous mill entering a square in the following stand, affording a typical example of the problems involved.

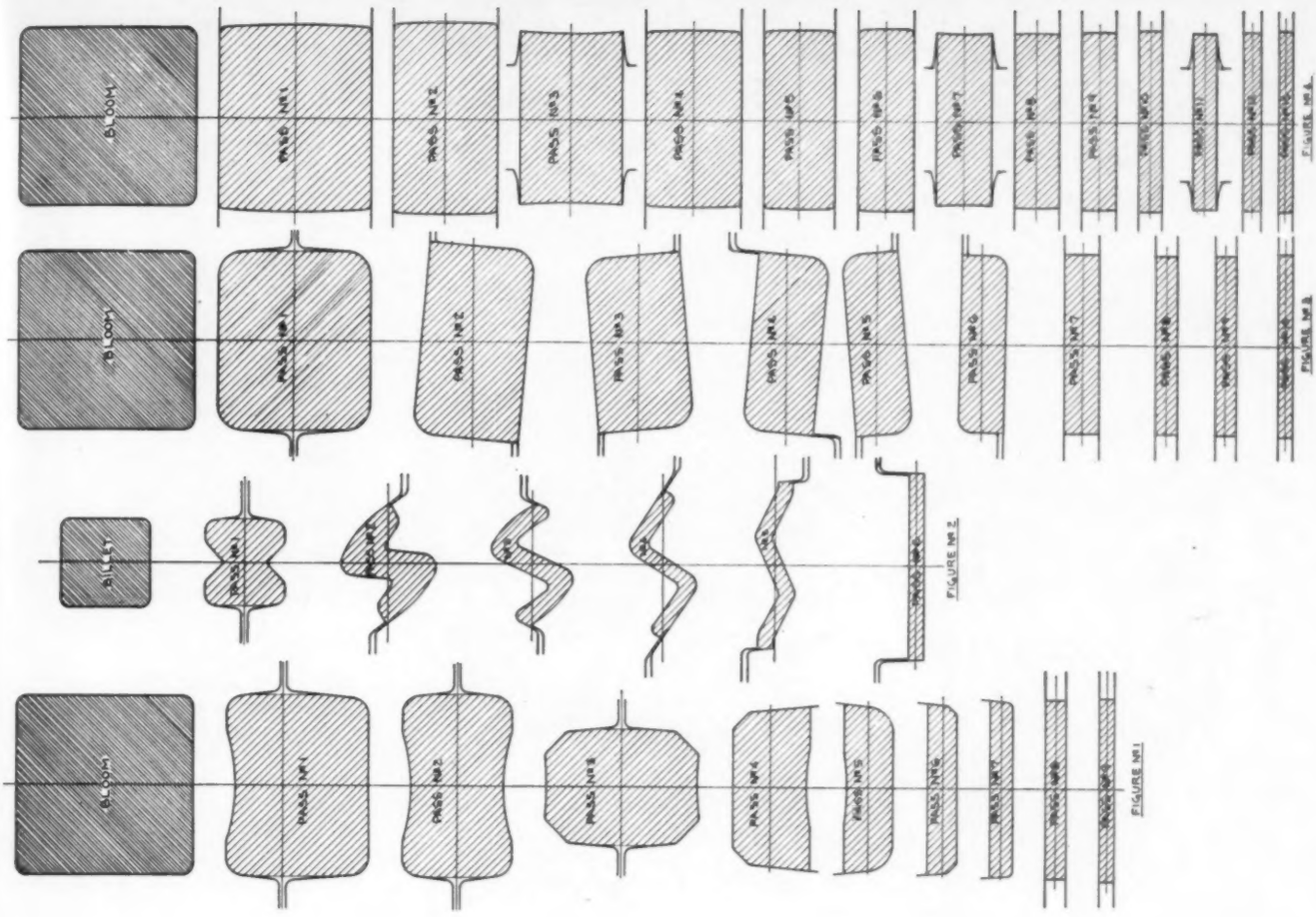
Stand No. 2 which is the finishing stand has 18 in. diameter rolls and operates at a speed of 100 rpm. The actual peripheral speed of the No. 2 stand rolls would not be computed on the basis of an 18 in. diameter, but at a somewhat smaller diameter because of the shape of the pass and the slippage of the bar in the pass. The determined diameter, known as the working diameter, is 16.875 in., which will give a peripheral speed of 442 fpm. This diameter allows for extrusion. The area of the 2 in. round cornered square finished is 3.94 sq in. and the area of the diamond from stand No. 1 entering the square is 5.30 sq in. The percentage of elongation between stand No. 1 and stand No. 2 is 5.30 divided by 3.94 which equals 1.345. This makes it necessary to have a peripheral roll speed for stand No. 1 of 442 divided by 1.345, which is equal to 328 fpm. Knowing the actual working diameter to be somewhat less than 18 in. or approximately 17 in., and knowing the peripheral speed, the rolls in stand No. 1 must then run at 73.8 rpm to have the correct speed. These figures must be worked out for each stand of a continuous train of rolls.

Drawing 22 shows three pass designs for rolling billets. The first is the box pass design, Figure 1. The features of this design are, first, that the roll is not cut into as deeply as is the case when a diamond or square is used, and second, that when turned from pass to pass, the bars will stand up on the tables. This design was rather widely used on continuous billet mills, but has been replaced to a large extent by the diamond and square design.

The second design shown, Figure 2, illustrates the diamond and square method of rolling. This layout makes a better billet than the box pass method because the rolls contact the bar on all four sides, whereas in the box pass method a true rolling action is secured only on the top and bottom, any contact on the sides being more of a grinding action than a rolling one.

Figure 3 illustrates a design known as diagonal rolling. In this design the four sides are rolled and compressed about equally and the tendency to spread is restricted. Further, the bars twist themselves because of the unequal roll diameters, this action being in the right direction to enter the various passes. In most places where this design has been tried it has been discarded because of excessive roll wear and the difficulty in adjusting the distribution of the draft among the various passes.

Drawing 23 shows four methods of rolling sheet bar. Figure 1 shows a combination of box passes, tongue and groove passes, and a couple of passes in plain rolls. The first three box passes serve to break down the bloom and edge it to the right size to enter the tongue and groove passes. These confine the width while reducing the thickness. Two finishing passes in hard smooth plain rolls give the bar a good surface. An unusual series of passes is shown in Figure 2. In this case a small billet is the only stock available and this spreading method is used to make a wide bar twice the size of the billet. The design shown in Figure 3 employs diagonal rolling in some of the passes. By this method, the edges as well as the flat are worked in the same passes. This system has merit where there is a tendency for cracked edges to develop.



Drawing 23 — Various pass designs for rolling sheet bar.

The fourth line of passes shown, Figure 4, is the one most commonly used in continuous mills. Plain rolls are used throughout and the width controlled by vertical edging stands. This method is used for both slabs and sheet bar and for this reason no special slab passes are shown.

Water under high pressure is sprayed on the sheet bars at a number of the last passes to crack and remove the scale as well as to cool the bars sufficiently to minimize the scale that will form on the bars while cooling.

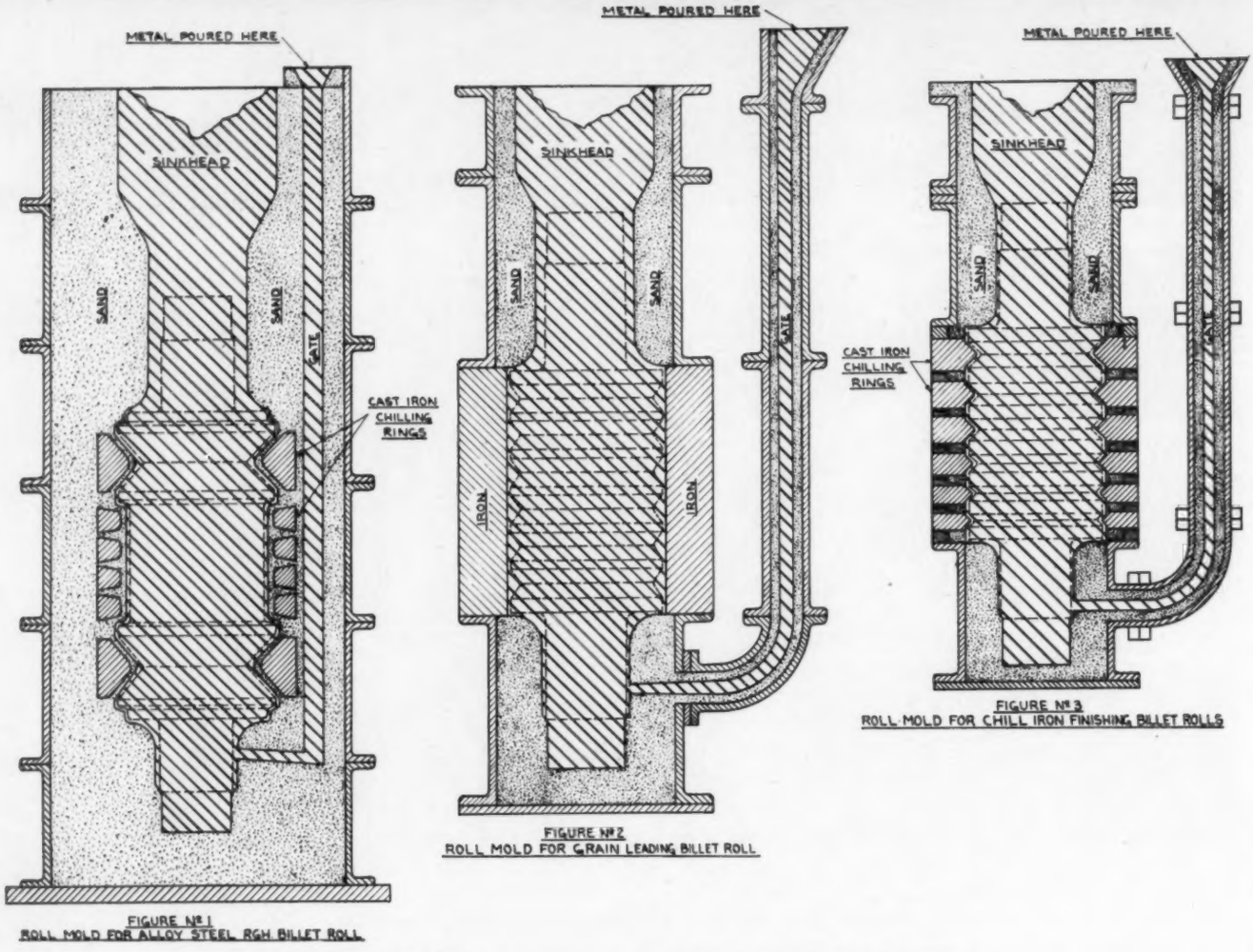
In a continuous mill the rolls may be driven by individual motors at each stand, or all or part of the roll stands may be driven through reduction gears from a line shaft powered by one or two motors. Those mills in which the rolls are driven by only one or two motors present some difficult problems to the roll designer. Tying roll stands together with a fixed speed ratio between stands makes it difficult, and in some cases impossible, to take care of the draft and elongation from pass to pass without feeding the steel too fast or too slow between the stands.

When a variety of steel analyses are rolled, the problem cannot be handled to the best advantage on a mill of the fixed drive type. When the speeds are constant from stand to stand, the only adjustments that can be made in draft and elongation are accomplished by changing the draft or roll diameter, and this of course has its limitations. When a mill has individual drives for each stand, pass variations in draft and elongation are adjusted by a change in roll speed. The additional expense of the drives is more than compensated for by a better product and longer roll life.

The 45 degree to 90 degree twisting of bars from stand to stand puts a heavy pressure on the twist guides, frequently developing scratches which are rolled into seams in the finished bar. A practical solution of this difficulty is afforded by the use of roller twist guides to relieve the pressure and by allowing sufficient distance between the stands to provide for a more gradual twist of the bar as it advances.

ROLLS FOR BILLET MILLS

Rolls for billet mills may be made of plain steel, sand iron, alloy steel, or alloy iron. Plain steel and sand iron rolls have been superseded almost entirely by the alloy steel or alloy iron rolls, which have greater strength and resistance to wear. Alloy steel rolls, properly made and heat treated, are far stronger than alloy iron rolls, the harder grades comparing favorably with the best alloy iron grades. Alloy iron rolls, of the type commonly



Drawing 24 — Molds for casting various types of billet mill rolls.

called "grain," can be used successfully for rolling the smaller billets or for sheet bars and slabs. In some cases a roll of chilled iron with the grooves chilled into the casting is used for finishing passes. Figure 1 on Drawing 24 shows a roughing billet roll mold and casting of alloy steel. This type of roll is used for three-high billet or sheet bar mills or on the roughing stands of a continuous mill.

The heat treatment of rolls such as this is much the same as that outlined for the blooming roll previously discussed. Figure 2 on Drawing 24 shows a mold and casting of a grain type roll such as is often used in the finishing stands of a continuous billet mill. This type of roll is usually cast plain in a chill mold, and the grooves cut in; the roll is not heat treated. Figure 3, Drawing 24, illustrates a chilled iron roll with the grooves roughly cast in. The dotted lines in each case show the finished outline of the rolls.

CONCLUSION

This paper as presented is a brief outline of the problems involved in the rolling of semi-finished steels. Any one of the phases mentioned here could be elaborated to advantage. Operators and designers are constantly studying the problems in an effort to improve the product of their mills and at the same time reduce their costs, but while great advances have already been made, much work still remains to be done.

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Continuous Electroplating OF STEEL STRIP

. . . . as a result of the impetus given electrotinning by war conditions, it is believed that the electroplating of various metals on steel will come into increasing use in post-war periods . . .

by D. A. Swalheim

ELECTROPLATING DIVISION

E. I. DU PONT DE NEMOURS AND COMPANY

CLEVELAND, OHIO

▲ THE subject of continuous electroplating of steel strip is of interest to the steel industry for a number of reasons. The thickness of coating can be accurately and readily controlled by the current applied and speed of the strip; labor costs are low for high tonnage production, and the metal coating is very uniform in thickness and relatively free from pores. Among other advantages, electroplating provides a means of coating steel with certain metals which cannot be applied commercially by any other method.

During recent years, the steel industry has taken advantage of a few of the potentialities offered by electroplating processes. The electrotinning of strip steel illustrates one large scale application. This discussion will be confined largely to electrotinning because it demonstrates the tremendous strides and progress made during a relatively short period of time.

The conventional hot dip process, which consists of passing the individual sheets through a pot of molten tin and through series of wringer rolls to remove excess tin, has inherent limitations with respect to the range of coating weights which can be commercially applied. The practical lower limit of hot dip tin coatings is about 1.25 lb per base box (112 sheets containing 217 sq ft of plate) which is equivalent to an average thickness of about 0.000075 in. Furthermore, the coating is not uniform in thickness and may vary from about 0.75 to 1.5 lb per base box from area to area on the same sheet.

The steel industry recognized the disadvantages and inherent limitations of the hot dip process, but nevertheless was reluctant to adopt the revolutionary electrotinning processes. Although a few electrotinning lines were in operation at the time of the attack upon Pearl Harbor, this event and others which followed, cutting off most of our tin supplies, compelled industry to utilize the advantages offered by electroplating. These advantages will become apparent in the discussion which follows.

ELECTROTINNING OPERATIONS

At the present time, there are a number of different tin plating electrolytes and also various types of equipment used in the industry. Any discussion relating to apparent advantages of any one process over others is premature at such an early stage of a relatively new and revolutionary development, and consequently this discussion will be confined to the halogen tin plating electrolyte developed by the writer's company with the horizontal type of plating equipment.

Installations using this particular type bath and equipment are in production at the present time at the Weirton Steel Company, Weirton, West Virginia, and

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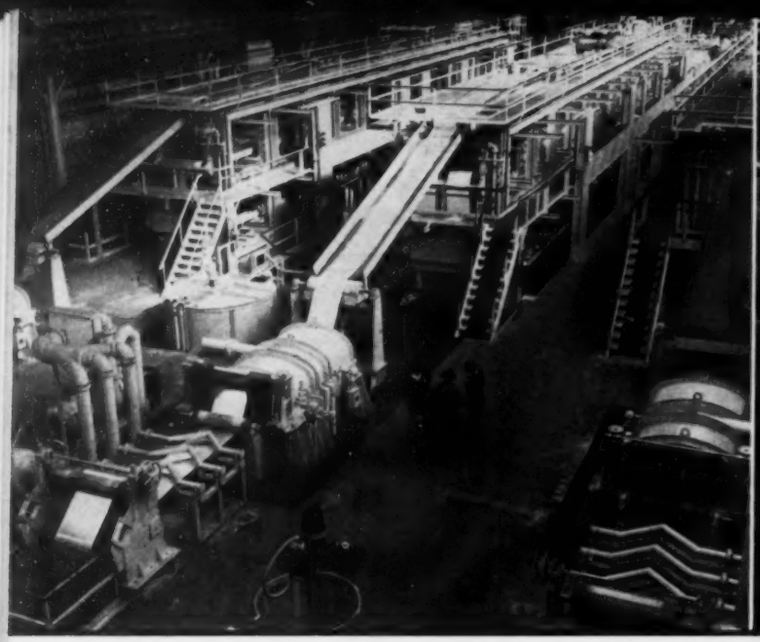


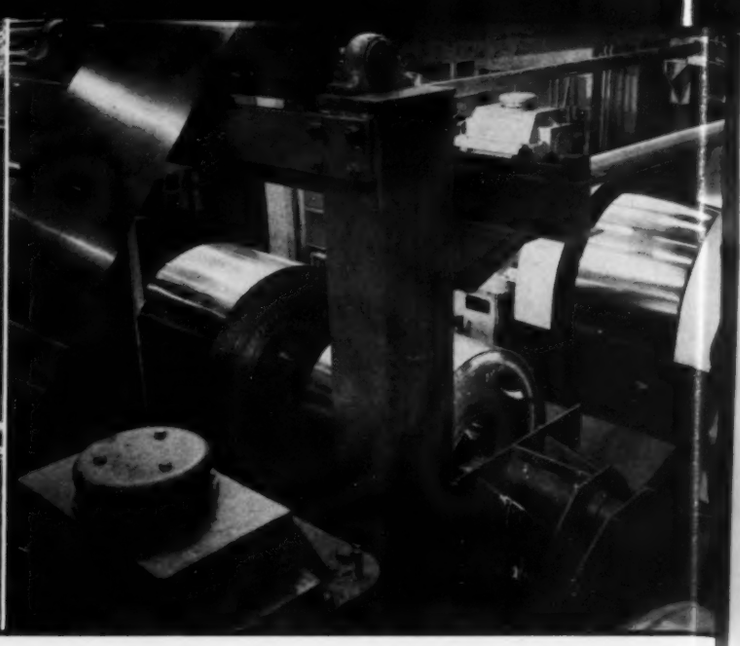


Figure 1 — Exit end of electrotinning lines. (left)

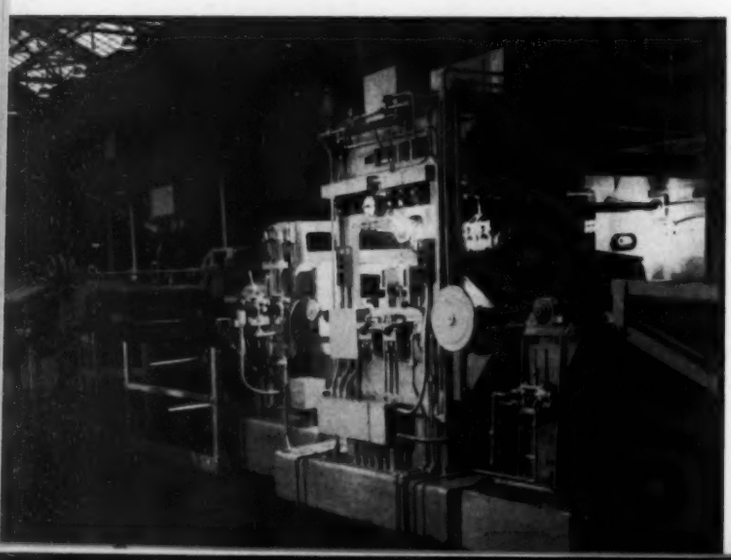
Figure 2 — View of entry end of electrotinning line, showing uncoiler with coils at center ready to be loaded on uncoilers. (right)

at the Republic Steel Corporation, Niles, Ohio. Weirton Steel has three units and Republic two units. Both companies employ essentially the same type of equipment. The equipment for this or any other electroplating process designed for handling strip at speeds necessary for economical operation is rather large and consists of a number of units as illustrated in one view of the plating line shown in Figure 1.

The overall length of the line is about 550 ft with a total of about 900 ft of strip required for threading. The plating line is designed and engineered to handle 36 to 22 gauge strip up to 38 inches in width at speeds up to about 1350 fpm.

The steel strip enters the unit at the uncoilers shown in Figure 2. In order to make the process continuous, coil ends are welded together at the front end of the line. The speed of the strip must be reduced to 100-200 fpm during the period the weld is made, as the storage loop in front of the uncoilers usually holds but 80 ft of strip. However, there are several other installations employing multiple loops which make it possible to weld the coil ends without changing the speed of the strip through the plating tanks. The welder is shown in Figure 3. Under normal operating conditions the length of strip in the loop pit is maintained by two photoelectric cells, one located with its light source below the bottom of the loop, and the other a few feet above it.

Figure 3 — Strips are fastened together for continuous flow by a high frequency induction welder.



The strip passes from the loop pit through the No. 1 drag unit into the electrolytic cleaning tank shown in Figure 4 where rolling oils and other foreign substances are removed by the electrolytic action of the alkaline cleaning solution. From the cleaning tank, the strip passes through a scrubbing unit and on through a pickling tank where oxides on the steel strip are removed. The strip then passes through a second scrubbing unit which rinses the strip free from acids.

PLATING ZONE

The strip passes from the pickling tank through the "horizontal type" plating unit, so called because the strip is plated as it passes through the unit in a horizontal position. The plating unit shown in Figure 5 consists of three decks with an overall length of about 100 feet. The lower side of the strip is electrotinned in the first deck. The steel strip is then reversed in direction and passes through the second deck where the other side is coated. From the second deck, the strip is again reversed and passes through a series of rinse tanks where it is washed free from electrolyte.

The general arrangement of the anodes and the steel strip is illustrated by the end view of a horizontal tank shown in Figure 6.

The current flow lines show the ideal conditions of current distribution, giving a uniform coating thickness across the width of the sheet except at the edges which have a somewhat heavier deposit.

The other common type of plating unit (not illustrated) employes vertical tanks in which the strip

passes through several U-shaped loops between vertical anodes. With this arrangement both sides of the strip are plated simultaneously.

Each of the two lower plating decks consists essentially of 12 individual plating cells which are rectangular trays located underneath, but close to the pass line as illustrated in Figure 7. The flow rate is approximately 30 gal per min per cell. The tin anodes located in the trays at a distance of about an inch from the strip replenish the electrolyte as the tin is plated on the strip. The electrolyte is pumped from the tank located underneath the plater by several pumps through a header which is equipped with by-passes to each of the individual plating cells. The electrolyte overflows at the entry end of the cell into return trays which convey it back to the tank.

The steel strip is maintained in a fixed horizontal position by the current-carrying contact rolls and rubber "back-up" rolls located between each of the individual plating cells. Once the total current in the plating cells is adjusted to produce a certain coating weight at a given speed, control is provided to vary the current automatically as the speed of the line is changed, thereby insuring a constant coating thickness regardless of the speed of the line. It should be emphasized that the voltage required for plating at a given current density depends on several factors, the most important of which are:

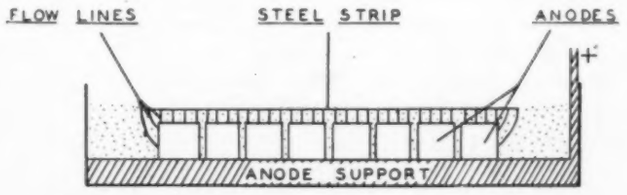
(1) Distance between anodes and strip
(2) Conductivity of electrolyte
(3) Polarization at electrodes
(4) Distance between contact rolls

Most of the electrotinning lines as described are equipped with a plating capacity of 120,000 amperes per line. The high capacity of the units is illustrated by the results shown in Table I.

The term "high speed plating" can be fully appreciated when one visualizes that the strip traveling at a 1000 fpm is coated with tin in a period of six seconds plating time.

The halogen tin plating electrolyte used in the installations at Weirton Steel and Republic Steel was developed primarily for high speed strip plating. A halide solution was selected for this purpose because of its excellent conductivity, which means minimum plating power consumption. The bath is very easy to control and is checked periodically by analysis and plating tests to insure optimum performance. The addition agents are added periodically as indicated by these tests. One of the unique features of the electrolyte is the very low organic content which is a contributing

Figure 6 — End view of horizontal tank, showing current flow lines.



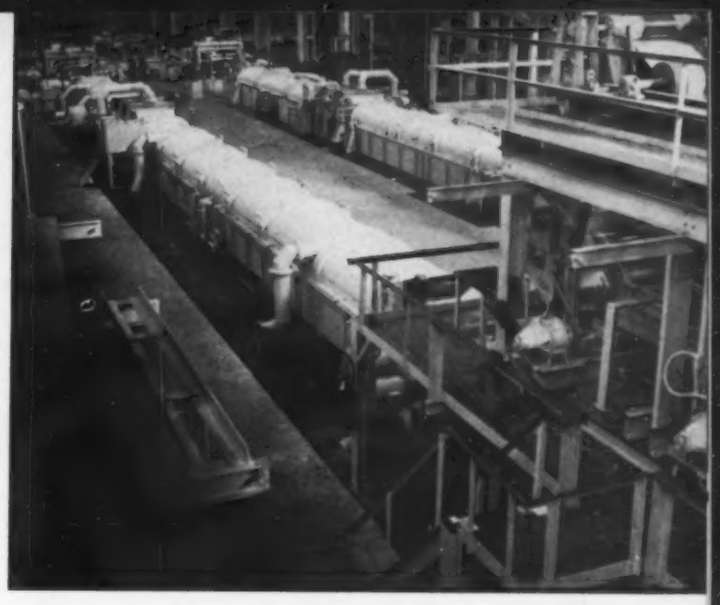


Figure 4 — Electrolytic cleaning, scrubbing and pickling precede the actual plating operation.

Figure 5 — View showing the electroplating unit.

Figure 7 — New tin anodes may be introduced without interrupting the operation of the line.

TABLE I — Production Capacity of Plating Lines

Coating weight, lb per base box	Speed, fpm	Total current required, amp*	Current density, amp per sq ft	Percent of total current capacity	Base boxes per 24 hr†
0.5	1000	75,000	235	63	15,000
0.75	1000	112,500	355	94	15,000
1.0	800	120,000	380	100	12,000

*Assuming a strip width of 30 inches.
†Assuming shut-down time of 10 per cent and allowing for lower speed during welding operations.

factor in the high purity deposit obtained from the bath. It is the consensus of opinion that deposits of high purity have greatest corrosion resistance.

The plating characteristics of the electrolyte are also periodically checked in a rotating cathode cell which simulates the conditions of the commercial lines. The cell consists essentially of a rotating cathode, which supports the 6 in. x 12 in. steel cathode, and an anode rack of special design. Laboratory results in the cell at speeds up to 1000 fpm have been found to closely duplicate commercial results with the electrolyte.

The strip is rinsed in hot water, dried, passed through a precision tension unit, loop and No. 2 drag unit, through the induction heating coils where the tin is melted.

The general apparatus arrangement for induction heating is illustrated in Figure 8. The apparatus for induction heating consists of a circuit breaker which connects the apparatus to a three-phase power line, an induction regulator or saturable core reactor to vary the power input with variations in speed and gauge of the strip, a transformer and rectifier which supplies high voltage d-c to the high frequency oscillators that generate approximately 200,000 cycle power for the induction heating coil through which the strip passes.

The flow line is held at a given position in the induction coils by means of photoelectric tubes and electronic regulators which control the power input as illutrated in Figure 9. Two light sources are mounted immediately in front of the middle of the strip, one just above the

Figure 8 — General arrangement of apparatus for reflowing by induction heating.

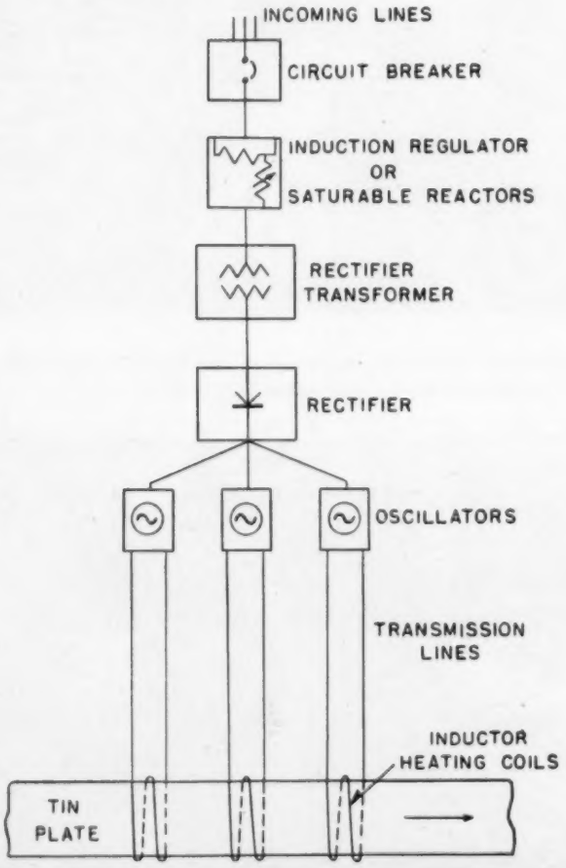
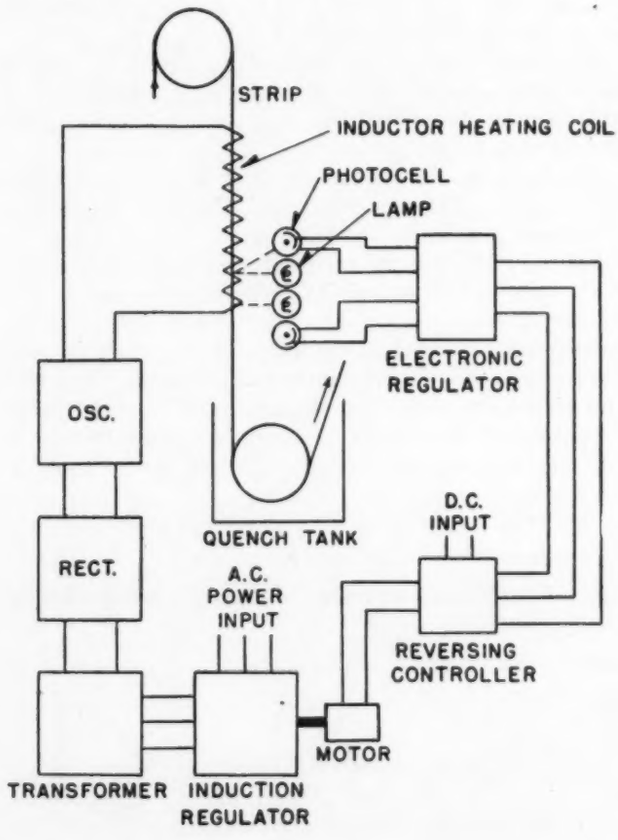


Figure 9 — Sketch showing equipment for temperature control for fusion of tin coating.



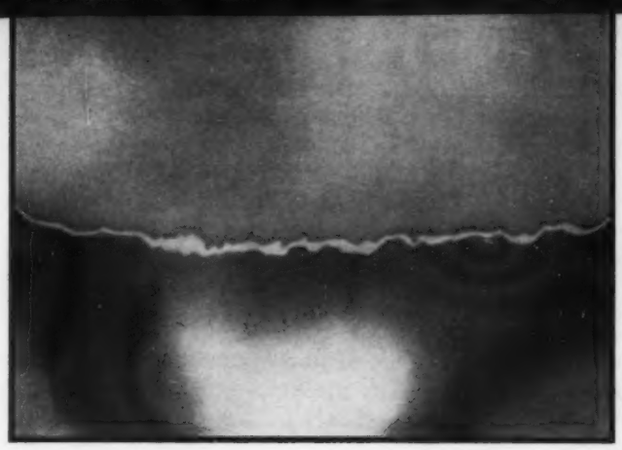


Figure 10 — Showing matte surface (top) of strip from plating unit, with inductively reflowed surface below the flow line.

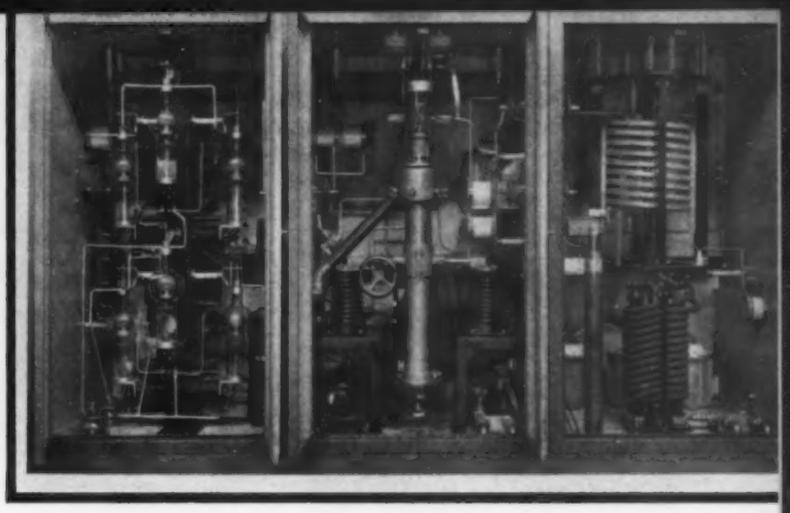


Figure 11 — This equipment provides power of the required characteristics for reflowing by induction heating. Rectifier tubes are at the left, oscillator tube, center, and reactors and capacitors at right.

position of the reflow line and the other just below. A photoelectric tube for each light source is mounted near its light source and approximately the same distance from the strip. The electronic regulator and auxiliary equipment operate a relay controlling the power input by regulating the voltage through an induction regulator thereby keeping the flow line in a fixed position. In this manner, the temperature can be held to a predetermined value regardless of gauge, speed of strip or variation in voltage of the power supply.

The strip is heated uniformly by the induction method as evidenced by the fact that the flow line varies very little from a straight line across the width of the sheet as shown in Figure 10.

The cubicle housing the high frequency equipment is shown in Figure 11. The cubicle to the left houses the rectifier which supplies high voltage d-c to the oscillator with auxiliary equipment shown in the center cubicle. The cubicle to the right encloses the tuning coil.

The problems of reflowing the tin can be appreciated when it is realized that these lines are accelerated from threading speed to full speed in 15 seconds. The induction method was selected because it permits quick and accurate power adjustment. Each of the installations at Weirton and Republic is equipped with six induction coils having a total capacity of 1200 kw per line which represents the power required to reflow the tin at strip speeds of about 1000 fpm.

The reflowed strip passes from the induction coils through the water quench tank which solidifies the tin. It then passes through a chemical treating tank, is rinsed, dried and coiled as finished product. Coils of the finished product are shown in Figure 12.

As mentioned previously, the application of electrotinning enabled industry to save critical supplies of tin because of the lighter weight coatings which can be applied by this method. At the present time, large quantities of 0.5 and 0.75 lb per base box tin plate are being produced commercially, demonstrating the success of the electrotinning process. The finished product is used for food packs, including vegetables, meat products and fish, for milk cans and other purposes.

The process is not limited to light weight coatings and can be applied equally well to give heavier coatings for use in the more corrosive food packs. Extensive evaluations are in progress at the present time to determine the weight of electrolytic coating required to give corrosion resistance equivalent to 1.25 lb hot dip. It is also anticipated that the process will be extended to applications of extremely light weight coatings of the order of 0.1 to 0.25 lb per base box for use in dry pack containers such as coffee cans.

PLATING OF OTHER METALS

Lead — Lead is of particular interest because of its excellent corrosion-resistant properties. There are at the present time, numerous uses for terne plate, but strip steel coated with lead has received very little consideration from the standpoint of applications and uses because of the difficulties encountered in attempting to apply lead to steel by hot dipping processes.

Reported results have indicated that a copper strike prior to lead plating gives a product of improved corrosion resistance and therefore may be highly desirable.

The lead plating process developed by the writer's company has been used commercially for some time and has proved satisfactory. Extensive work is being undertaken at the present time to adapt the process to strip plating.

Figure 12 — Finished coil of electrotinned strip in bright finish.

Lead-tin — Numerous uses for light weight electrolytic lead-tin coatings over steel of the order of ½ to 1 lb per base box have been suggested, including containers for oil cans, polishes, waxes, antifreeze, paint and for other purposes where corrosion is not a serious problem. Investigations and evaluations are in progress at the present time to determine effect of flow-brightening lead-tin deposits. It is anticipated that this treatment will improve the characteristics of the coatings. Heavier coating weights can also be produced by the process giving better corrosion resistance because of the added protection of the additional coating.

Zinc — Zinc can be plated either in the dull or bright finish. For numerous applications the corrosion protection offered by zinc is of primary importance and the lustre secondary. This is particularly true if the product is bonderized or painted and therefore the added cost of producing bright deposits is not warranted. The chloride acid zinc bath has been used almost exclusively for producing dull deposits because of its excellent conductivity. The anode and cathode efficiencies are high even at current densities of the order of 400 amp per sq ft.

The demand for bright zinc deposits will presumably increase after the war emergency when products again become more competitive and appearance plays a larger role. The high speed zinc process appears to offer the requirements essential for high speed strip plating. The deposits from this electrolyte, a cyanide solution, are very bright and ductile. Ductility is of great importance especially if the product is subjected to forming or stamping operations. The bath can be operated at current densities up to 400 amp per sq ft with cathode current efficiencies of the order of 90 per cent.

CONCLUSIONS

During the past two years, plant capacity for electrotinning has expanded tremendously. Since electrocoatings may be deposited to the thicknesses demanded by specific uses, electroplating will undoubtedly be applied even more extensively in the future. The deposits are more uniform in thickness and relatively pore free in comparison to hot dip coatings. Electrogalvanizing of strip steel has been carried out successfully for some time. In the near future, other metals including lead, lead-tin alloys, copper, brass, nickel and different dual coatings may find extensive applications applied to strip steel.

DISCUSSION

PRESENTED BY

A. L. NIELSEN, Development Engineer, Sharon Steel Corporation, Sharon, Pennsylvania

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E. C. FRIEDL, E. I. duPont deNemours and Company, Inc., Electroplating Division, Cleveland, Ohio

K. W. HARRIS, Electrical Engineer, Warren District, Republic Steel Corporation, Warren, Ohio

D. A. McARTHUR, Chief Engineer, The Wean Engineering Company, Inc., Warren, Ohio

CARL C. JONES, Special Engineer, Youngstown Sheet and Tube Company, Campbell, Ohio

H. A. SHERER, Chief Engineer, Reeves Steel and Manufacturing Company, Dover, Ohio

N. J. RANNEY, Assistant to Chief Engineer, The Wean Engineering Company, Inc., Warren, Ohio

A. L. Nielsen: The slow speed of flow-brightening at Crucible Steel is because this installation was the pioneer development in the brightening of electro-tin plate by hot and cold oil baths. Since this first installation was made, almost unbelievable progress has been made in the brightening of electro-tin plate in oil baths, and I would like to make a few remarks concerning these later developments.

Dr. Swalheim has mentioned quite a bit about savings of labor and other economies, but it seems to me that they have gone only a very short way in the matter of simplification of their tinning line, and in the economy of operation. I am sure that after the war is over, and we get back to living under normal conditions, the matter of economy of operation of the electro-tinning lines will be of greatest importance. The volume of tin plate produced is so great that a few cents per ton saved will amount to millions of dollars per year.

It is my understanding from very reliable sources that the cost of brightening the electro-tin plate by high frequency is about $1.25 per ton when a correct accounting is made. That is, when its share of amortization, expert labor, maintenance, and operating costs is considered. The high frequency power is extremely inefficient.

The cost of brightening electro-tin plate with hot and cold oil baths at the present stage of development, and at strip speeds of 500 to 1000 fpm would be 15 to 17 cents per ton, based on a correct accounting as stated above. Furthermore, the tin plate as delivered from the oil brightening apparatus will be in condition to pack and ship to the can manufacturers. The residue of the oil on the brightened tin plate is sufficient to lubricate the tin plate in handling and in can fabrication, but will not become rancid, stain the tin plate, or interfere with the standard procedure of can making. The oil film will not interfere with lacquering or enameling. Therefore in addition to being economical, the oil brightening operation may eliminate other operations such as branning, oiling, etc., as used subsequent to the high frequency brightening.

D. A. Swalheim: What is the maximum speed at which you have operated with oil flow-brightening?

A. L. Nielsen: We have operated at 165 fpm with a hot oil tank 28 inches deep.

D. A. Swalheim: Don't you anticipate difficulties in recovering the oil economically at high strip speeds?

A. L. Nielsen: No. We have been working with one of the larger research organizations of this country, and have had our designs checked by some very prominent engineers, and they all agree that at a strip speed up to 1000 fpm we will not experience any serious difficulty in operation. The overall height of the oil baths will not exceed 25 feet.

It might be well to mention the ease of control of the oil brightening system. I have operated our line over a speed range of 16 to 1 without changing any controls

on the oil brightening system, and the tin plate brightened satisfactorily over the entire range of strip speed. One reason for this is that the temperature of the hot oil bath is controlled by simple thermostatic controls to a value only slightly above the melting point of tin, or about 500 F. The tin plate cannot exceed the temperature of the surrounding oil. The tin plate is heated very rapidly up to the melting point of the tin coating, and then tapers off in rate of heating, and only approaches the temperature of the oil, never exceeding it, regardless of the time in the hot bath.

On the other hand in high frequency heating the temperature rise is very rapid, and does not diminish in rate above the melting point of the coating. What is the figure on rate of temperature rise?

E. C. Friedl: In this case I think it figures about a second at 1000 fpm.

A. L. Nielsen: At that rate of heating the temperature of the strip would be well over 1000 F in a couple of seconds, and, therefore, success of operation depends on a very intricate control. In the oil bath there is no danger of burning the strip because the temperature head limits the maximum strip temperature. As I said before, we have actually operated our line from 165 fpm down to 10 fpm with no change in the appearance or quality of the tin coating. In our laboratory we have operated over a much wider range.

K. W. Harris: Naturally our corporation did not purchase high-frequency flow brightening equipment without our doing a good bit of study and investigation. One of the matters given considerable attention was the estimated cost to reflow a base box of tin plate. We set up theoretical figures for power consumption, theoretical efficiencies, etc., and it finally worked out to where actual cost was estimated to be about 2½ cents per base box, including tube replacements. I would like to point out that we had no background experience with this type of equipment doing this kind of work, nor had anyone else at that time.

We now have had the high frequency equipment in operation for about eight months and have made two checks on power costs. I was a little amazed to find that our preliminary estimated cost of operation was just slightly higher than our cost found during actual operation.

We are not too sure but that our power cost figure is a little high, because there are factors in the readings that we couldn't check exactly and so we had to do a little estimating. We made very sure that our estimated power for filaments, water pumps, etc., was definitely on the high side. Using the actual power cost found, and based on replacing oscillator tubes after 7500 hours of operation, and rectifier tubes after 2500 hours of operation, which are the tube life expectancies, if I remember correctly, the total average cost to reflow is slightly less than 2½ cents per base box, based on our experience to date.

This actual cost is considerably lower than the figure given by Mr. Nielsen for induction reflow equipment. I would like to repeat that our figures are based on our experience to date. Incidentally, it may be of interest to you to know that our over all efficiency which we were told could be expected to be approximately 50 per cent, actually seems to work out to approximately 60 per cent.

D. A. Swalheim: Do you have any idea what your power cost is in comparison with Weirton?

K. W. Harris: As I recall, I have heard they estimate their power costs in the neighborhood of 1 cent per base box. I am not familiar with their power set-up; however we purchase practially all our power.

One of the problems of people who have handled tin pots for a number of years — and, of course, they have been with us for a long time — has been the flashing of hot palm oil. We have all had fires in our tin houses and some of them have been pretty bad.

We discussed oil brightening as a part of our flow brightening investigation. It was brought out that this process required a large quantity of oil kept at elevated temperatures which would naturally constitute a potential fire hazard. As a part of good safety engineering we try to avoid, wherever possible, the use of hot oil or any other material that is such a potential hazard. I am sure that our fire and safety departments were glad to see our engineering department incorporate a reflow process in our tinning lines that does not contain an inherent possible source for bad fires.

I might make one more point that will be of interest to engineers. I think anyone who has had contact with the WPB has had a lot of pressure put on them to use the absolute minimum amount of copper in any form, on new construction jobs. In installing our electrolytic tinning lines at Niles, including all the copper bus bar on the platers, all the bus bar that we used for other uses such as electrolytic cleaning tanks, all the wire, all the cable, etc., our requirements totaled up to approximately 52 tons of copper.

As a part of our low voltage rectifier investigation to see whether or not it was feasible and advantageous to install rectifiers instead of plating motor generator sets, we estimated the total amount of copper that would have been required to install our two lines, using generators. We found that it would have required 106 tons of copper total, instead of 52 tons using rectifiers.

In other words, by installing rectifiers right alongside our platers, we figure that we saved in our installation more than half the amount of copper that we would have had to use with generators. This saving in copper was a factor in our deciding to install rectifiers, and at the time we made the decision, that saving was quite important. Of course, the copper situation has now eased up somewhat, but we like to think that our decision two years ago helped to make a few extra bullets when they were badly needed.

D. A. McArthur: I thought I understood Dr. Swalheim to say that the cyanide zinc plate coat there was very ductile. I have been led to believe otherwise — that the bright cyanide coat was quite a bit more brittle.

D. A. Swalheim: A cyanide bath can, of course, be operated without addition agents. The deposit from the bath is semi-bright but does not have the brilliance characteristic of deposits obtained from cyanide baths containing brightening agents. However, bright deposits from cyanide baths containing the proper addition agents are sufficiently ductile to withstand rather severe stamping operations.

D. A. McArthur: Have you any figures as to the ductility of the bright cyanide, the not-so-bright cyanide and the acid deposit?

D. A. Swalheim: Unfortunately, we don't have those figures. There are a number of factors involved in approaching the problem of estimating the chemical cost of operating a cyanide zinc solution which are difficult to simulate in laboratory practice. The only logical method for arriving at costs is a commercial installation.

As far as chemical cost is concerned, cyanide baths undoubtedly cost more than acid zinc baths to operate. However, the quality of the deposit is superior especially with reference to appearance. Bright deposits should find many applications as a decorative finish in addition to applications where corrosion protection is of primary importance.

Carl Jones: I don't want to let this alkaline zinc thing drop. We are not talking about organic additions to get brightening. We want the same kind of zinc in both instances; we have one authority that comes along and tells us we can use the cyanide zinc and that the additions for the loss of chemicals are about the same as if it were acid.

Now someone else comes along and says it is going to cost you 7 cents for every pound of zinc you put on if you use cyanide, for lost chemicals. What becomes of the chemicals? Does the cyanide go off as a gas and you have to replace it chemically? What are the facts?

E. C. Friedl: That depends upon the temperature of your bath. We do not have a commercial operation of strip of cyanide zinc. We just don't know yet.

D. A. Swalheim: Cyanide baths would undoubtedly cost more chemically to operate than acid zinc baths.

H. A. Sherer: What were the speeds on the zinc coating and how heavy do you think you are going to go practically with the reasonable cost? What is going to be the determining factor on heavy coating?

D. A. Swalheim: I don't recall the speed at which the sample deposit was made but we feel reasonably confident that the cyanide bath can be operated at current densities of the order of 250 to 300 amperes per square foot with cathode current densities of the order of 85 to 90 per cent under strip plating conditions.

We have no information on the economics of producing either light or heavy weight coatings.

D. A. McArthur: Isn't it also true that you deposit roughly about as much zinc as tin for the same current? Your figures wouldn't be radically different if you put zinc up there, would they?

D. A. Swalheim: They will be higher.

D. A. McArthur: The reason I was bringing that out, galvanized sheets have from three-quarters of an ounce to an ounce and a half of zinc per square foot and that is some ten times more than the half pound and three-quarters pound per base box we are talking about for tin plate.

N. J. Ranney: Is it practical to plate both sides of the strip simultaneously in a horizontal plating bath such as you have been explaining? I am not trying to bring up a comparison between horizontal and vertical, but in your discussion you stated one side was plated at a time.

D. A. Swalheim: I don't think it makes a great deal of difference. To plate both sides simultaneously it may be necessary to have the contact rolls closer together.

K. W. Harris: No, that isn't the answer. It is just that mechanical difficulties encountered in coating both sides at the same time in a horizontal plater, seem to make the thing look impractical. The idea of plating different weights of coating on the two sides was considered important for flexibility, so it was just a combination of anticipating mechanical trouble in design and operating difficulties rather than any particular decision that it could not be done. I wouldn't say it cannot be done.

D. A. Swalheim: If excessive current was applied to the contact rolls difficulties in arcing at the line contact with the strip may be encountered.

K. W. Harris: It is a wet contact though, with a very conductive solution, which makes an ideal condition for a good contact between the roll and the strip. We have had very little arcing trouble, as you probably know.

D. A. Swalheim: I wonder what troubles would be experienced if you doubled the current across the contact rolls.

K. W. Harris: That is a question I wouldn't know how to answer. I understand they have no trouble with arcing at Weirton and I know that currents more than twice our design value of 120 amp per inch of roll face have been successfully handled by contact rolls in conduction reflow experiments.

E. C. Friedl: I can see another disadvantage of plating horizontally both sides simultaneously and that is if the solution is not wholly free from particles, some of these particles might settle on the top side of the sheet, making it rougher than the bottom side of the sheet.

A. L. Nielsen: In a plater such as has been described, don't you have the solution circulating at a very high rate of speed so this matter of settling of small particles would not be apt to occur?

D. A. Swalheim: We've experienced no difficulty due to particles settling on the top side of the strip because the agitation provided by the strip traveling at 1000 fpm gives very good solution circulation.

A. L. Nielsen: What about the plating of the contact rolls? I mean electroplating in operation? It seems that you have quite a pool of solution between the contact roll and the strip which would tend to make the strip anode and the roll cathode.

D. A. Swalheim: If the solution is prevented from coming in contact with the nip of the roll on the opposite side no difficulties due to tin plating on the contact roll are encountered. In other words, a pool of solution adjacent to one side of the roll is not objectionable.

K. W. Harris: Our trouble has been with solution drying on the contact rolls. When you stop the plating line, the solution quickly dries on the contact rolls, and crystals form. These crystals are very tenacious and you have to remove them with a stone, but I understand we find little evidence of plating, at least not cumulative plating causing buildup on the rolls.

A. L. Nielsen: It looks as if the reason may be the relative size of the solution pocket. On the outgoing side you may get a greater concentration of current. However, you won't get any tin off the strip in the first plating deck as I understand it. Then on the return path in the second deck you do have tin on the top of

(*Please turn to page 82*)

FACTORS AFFECTING

Ingot Product Surface

. . . . from observations on some 500 heats of low alloy steel, evaluations are made of some of the many factors which influence the surface of semi-finished steel . . . .

by H. F. Lesso

PROCESS CONTROL METALLURGIST

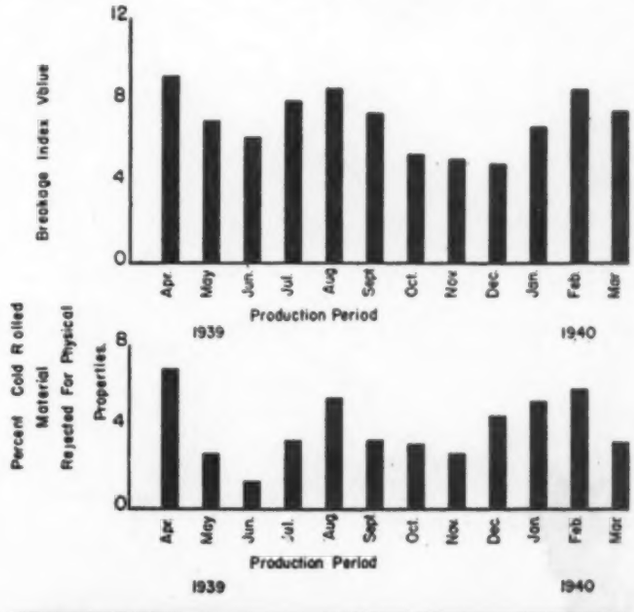
GREAT LAKES STEEL CORPORATION

ECORSE, MICHIGAN

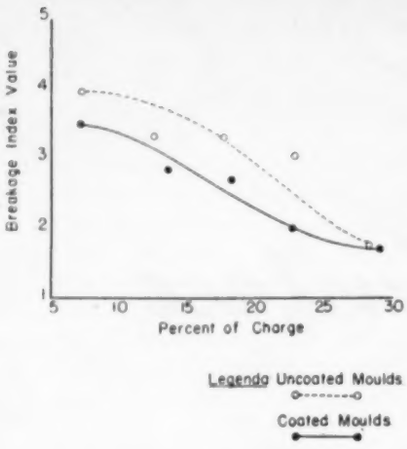
▲ IN the literature of recent date relatively little attention has been given to the problem of surface quality of semi-finished ingot product. In the numerous discussions on the physical metallurgy of low alloy steels, the great majority have been largely concerned with the treatment and physical properties of the material following the final rolling of the semi-finished product. Many vital and fundamental operations, however, precede this stage of metallurgical interest in this low alloy steel, those of the hot-metal division or more recently known as process metallurgy. Of the many variables constituting process metallurgy this brief discussion will deal with only those whose influence has been observed to bear directly upon the surface quality of the semi-finished ingot products at the blooming mill.

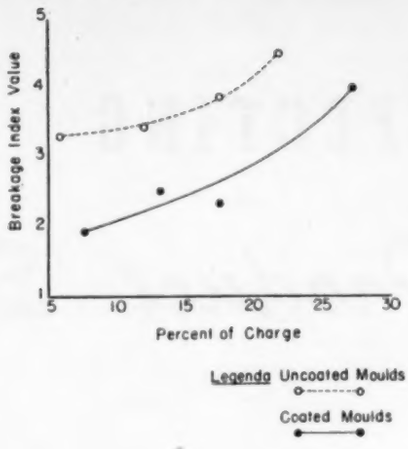
Never in the history of the industry has surface quality of semi-finished products been of greater economic importance. Present demands to fill our military needs have served to further emphasize the importance of surface quality. Without meticulous attention given to these surface defects, they may not only result in prohibitive resurfacing costs and utter waste through

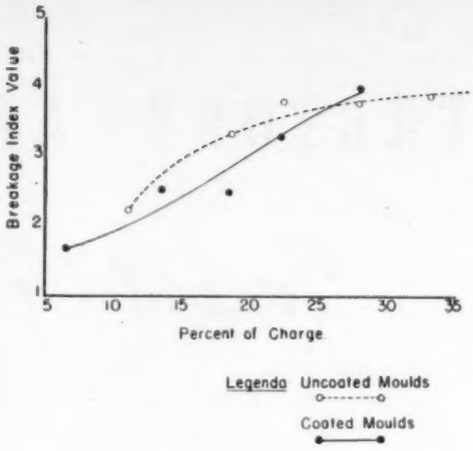
Figure 1 — Charts showing similarity in records of breakage index value and rejected material.



Presented before A. I. S. E. DETROIT District Section Meeting, January 11, 1944.







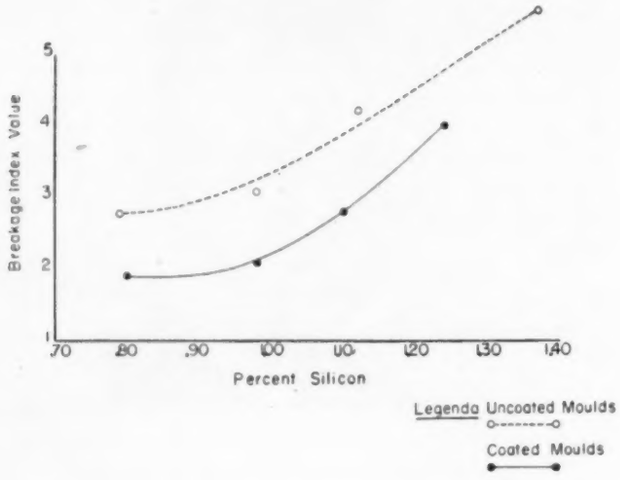


Figure 2 — Light scrap in the open hearth charge vs ingot breakage. (above left)

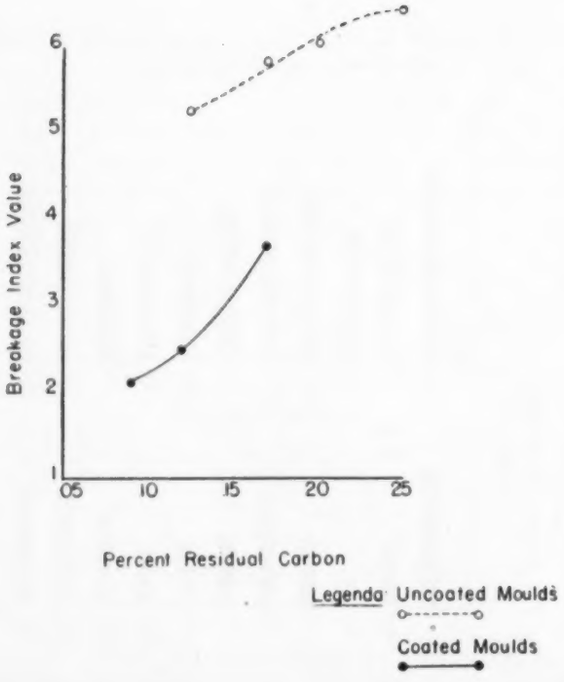
Figure 3 — Heavy scrap in the open hearth charge vs ingot breakage. (above center)

Figure 4 — Alloy scrap in the open hearth charge vs ingot breakage. (above right)

Figure 5 — Effect of silicon content of pig iron upon ingot breakage. (left)

Figure 6 — Variation of ingot breakage with final preliminary carbon in the heat. (bottom left)

Figure 7 — Variation of ingot breakage with residual manganese in the heat. (bottom right)



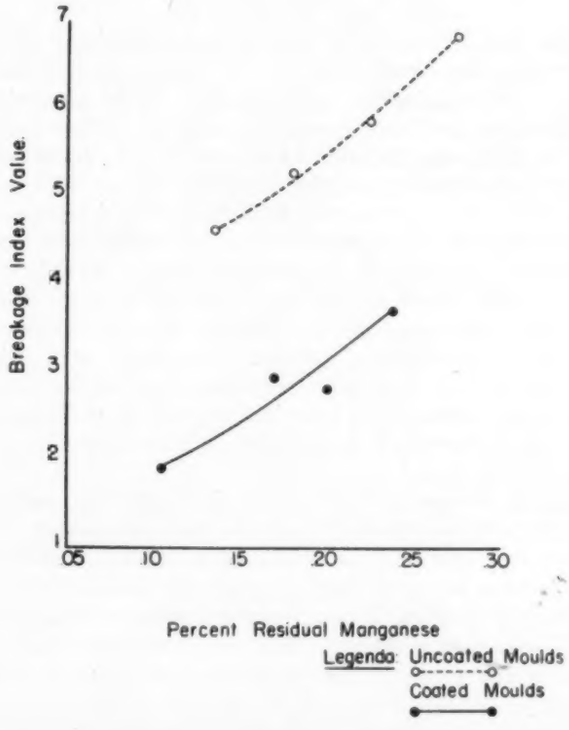


Figure 8 — Variation of ingot breakage with varying ratio of final residual Mn/C. (right)

Figure 9 — Final phosphorous content vs ingot breakage. (right center)

Figure 10 — Final phosphorous content vs elapsed time between minimum phosphorous test and tap. Solid line shows residual manganese. (right bottom)

excessive rejection of finished product (which also does not permit of economical operation) but most vital, the slow movement of military materials.

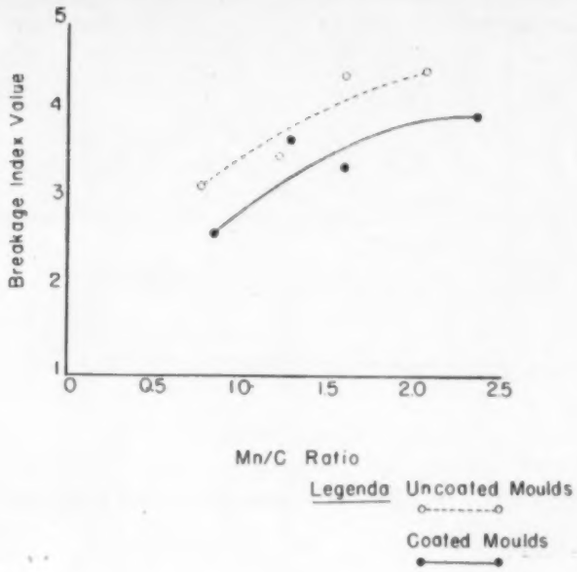
It is readily apparent that the frequent and varied attempts to control surface quality have met with relatively little permanent success when attention was focused upon some one isolated factor, since with each attempt it has been repeatedly found that the contributory factors to defective ingot surface were indeed considerable in number. However, with careful evaluation of those fundamental operations known to most directly influence ingot surface quality and with thorough understanding as to their relative importance on the part of those assigned the responsibilities of practice, some reasonable degree of permanent improvement should result. It must be remembered that any outlined practices covering these fundamental operations should represent the best practical compromise between conflicting variables.

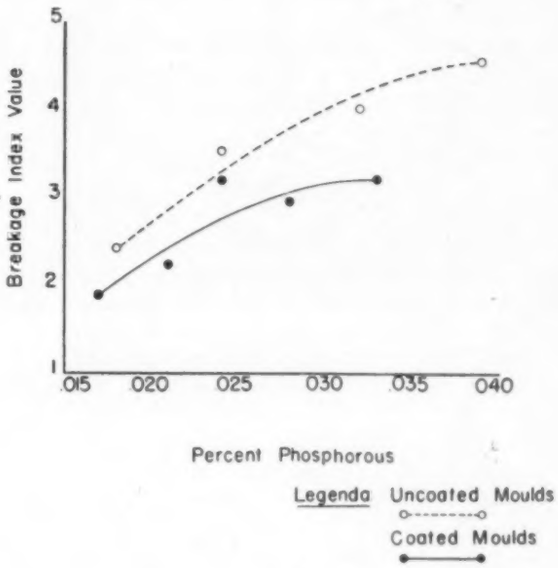
One factor of prime consideration in holding ingot breakage to a basic minimum is a well prepared ingot mould. This is perhaps one of the most effective measures for insuring high surface quality in steel making. A well prepared interface with a dressing which melts or volatilizes as the liquid steel comes in contact with it, creating a light rolling of the metal at that location, will effect, through improved soundness of the cast ingot surface, very substantial economies in time and materials in subsequent operations. Further discussions on the essential features of mould preparation practices will be dealt with later.

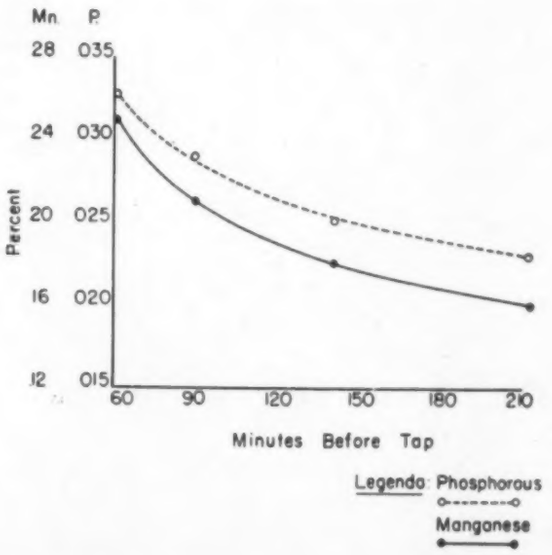
In considering the fundamental causes for breakage of low alloy steel ingots at the blooming mill, the units of operation included in this statistical study will be presented in such order as to be consistent with the normal sequence of operations, i.e., materials in the furnace charge, general refining, mould preparation, and teeming practice, mechanical handling and soaking pit operations.

Before initiating this discussion, brief explanation must be given to the meaning of breakage index value. The values shown on the ordinate line of the curves are assigned numerical values to the frequencies with which serious ingot breakage was observed to develop in the three ingot sections (butt, middle and top) into which each ingot was sub-divided with imaginary lines during the actual rolling operation, the increasing value of the index number indicating increasing surface defectiveness.

The relative evaluation of ingot breakage naturally is dependent upon the skills developed by those engaged in metallurgical observations. That these observational data can be employed as an added means of indicating trends in surface quality early in operations







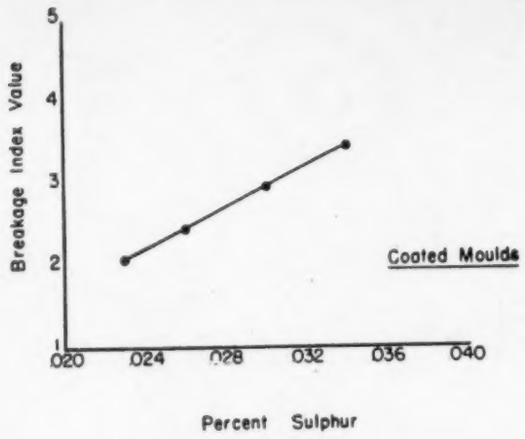


Figure 11 — Final sulphur content vs ingot breakage.

can be confirmed rather well by the similarity of the two curves in Figure 1.

At this point it might be well to explain that the data to be presented were obtained from the rolling observations of over 100,000 tons of low alloy steel.

RAW MATERIALS

It is a function of the steel making department to compensate for the multiple variables in the chemical and physical properties of the raw materials and to deliver ingots to the rolling mills, which, for any grade of steel, must be uniform in both chemical and physical features.

Under normal furnace operation, scrap materials in the furnace charge of certain composition and weight classification were found to have relatively well defined quantitative limits in their influence upon favorable refining conditions. During the melting period the scrap is oxidized continuously by the furnace gases. The total amount of oxidation is a function of the temperature, the physical character of the scrap as to size, surface area exposed and the time between charging and under cover (which is when sufficient scrap has been melted that a thin layer of slag covers the metallic mass).

The melting period of any furnace charge, no matter how well the scrap may be proportioned to reasonably hold the oxidation within that range from which favorable refining practice may be effectively carried on, will be altered immeasurably by flame character. A blowtorch flame employed in melting practice, while it shortens the melting period, results in excessive oxidation which in turn causes considerable operating difficulty and usually consumes more time in its correction than that which is gained in the reduced melting period.

With normal melting practice the relative proportions of light scrap, heavy scrap and alloy scrap found to produce the most favorable results not only in refining conditions but also in a semi-finished ingot product with a minimum of surface defects are shown in Figures 2, 3 and 4. respectively.

In Figure 2, dealing with light scrap, it will be noted that from 25.0 to 30.0 per cent is the proportion from which a product with a good surface quality has resulted. In considering heavy scrap in Figure 3, up to

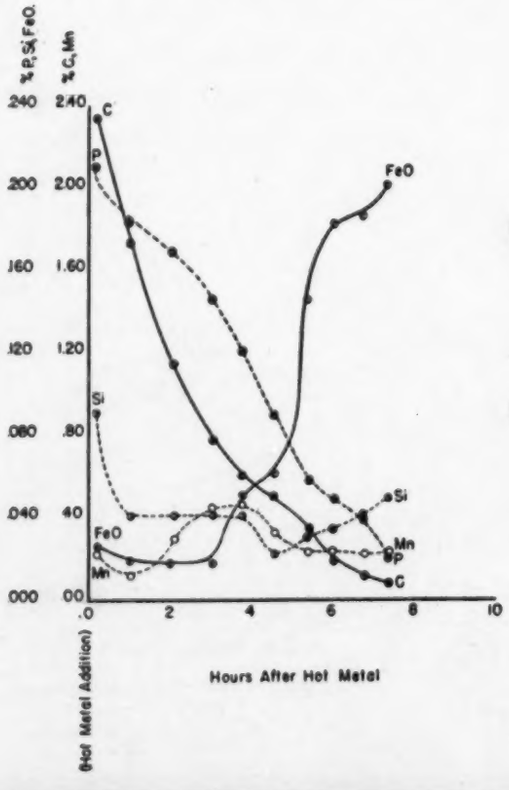
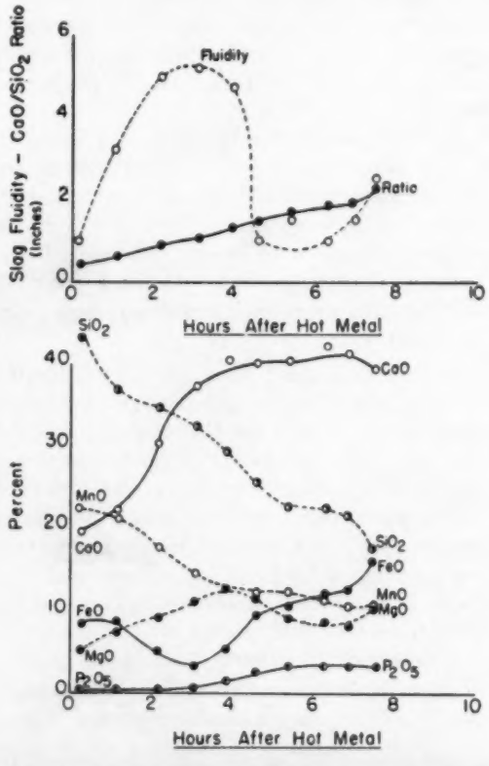


Figure 12—Metal chemistry on a heat of low carbon steel in which total charge silicon was high.

Figure 13—Slag chemistry on the heat charted in Figure 12.



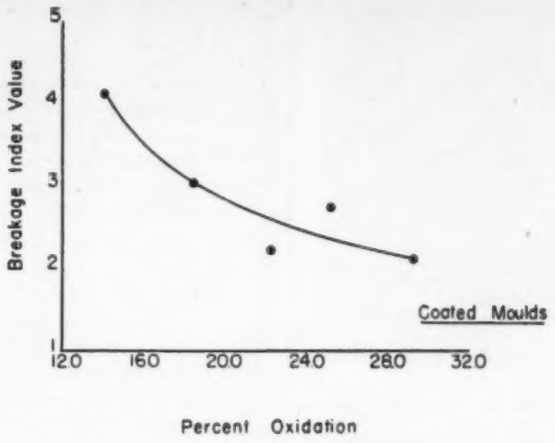


Figure 14 — Final FeO content of slag vs ingot breakage.

15.0 to 17.0 per cent appears to be that quantity from which a reasonably good quality of surface can be expected of the semi-finished product. In Figure 4, the range of alloy scrap in a furnace charge which still permitted favorable operation and a good resulting product is revealed to be around 15.0 per cent. The chemical nature of alloy scrap entirely governs its quantitative limits in a basic open hearth charge. Abnormally large quantities of highly alloyed steel scrap are definitely not conducive to good refining conditions in stationary basic furnace operation.

Of the acid elements dealt with in basic operation silicon, because of its multiple influences, receives considerable attention in the preparation of furnace charges and refining operations. The meaning of silicon in the refining problems evolving from its presence has been indeed well appreciated by steel makers for many years. Figure 5 readily interprets the influence of charge silicon on surface quality of ingot products at the blooming mill. The trend very definitely indicates that the silicon chemistry of the raw material, pig iron, should not exceed 1.00 per cent. The multiple influence of charge silicon in the refining operation is so pronounced that its importance cannot be minimized. Without delving into theoretical discussion and speculation the more immediate phases of operation effected by the presence of silicon are:

(A) Melt-down ranges,
(B) Physical characteristics of finishing slags,
(C) Rate of iron oxide transfer from slag to metallic bath, which in turn determines the rate of carbon loss,
(D) Removal of phosphorous and sulphur from the metal through their chemical affinity for the available calcium oxide.

Judging from statistical evidence available on the influence of silicon, both in steel making and upon the physical properties of rolled products, a most interesting treatise could readily be written on this singular element.

GENERAL REFINING

In the refining cycle, the ranges of final preliminary carbon and manganese found in the bath when the finishing slags were in good fluid basicity were .10 to .12 for carbon and .10 to .15 for manganese. Figures 6 and 7 illustrate quite clearly that reasonably good surface quality may be expected from such refining practice. Ready confirmation of the findings on the final carbon and manganese residuals can be found when a ratio value of manganese to carbon is established and plotted versus breakage index. The more nearly the

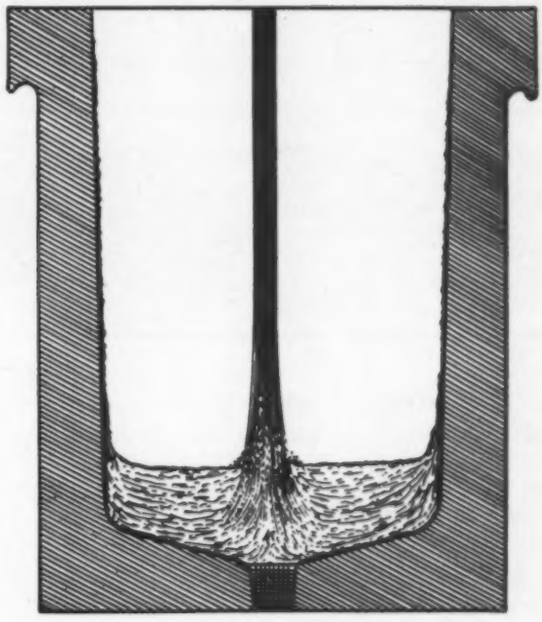
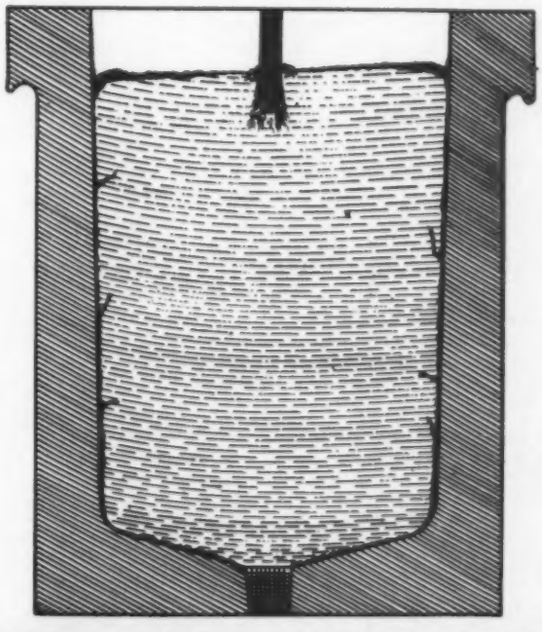


Figure 15 — Illustrating spatterings adhering to rough wall surface of uncoated mould, as well as encrustment formed at surface of liquid metal.

▲

Figure 16 — Segments of encrustment trapped on rough wall surface of an uncoated mould result in ingot surface defects.



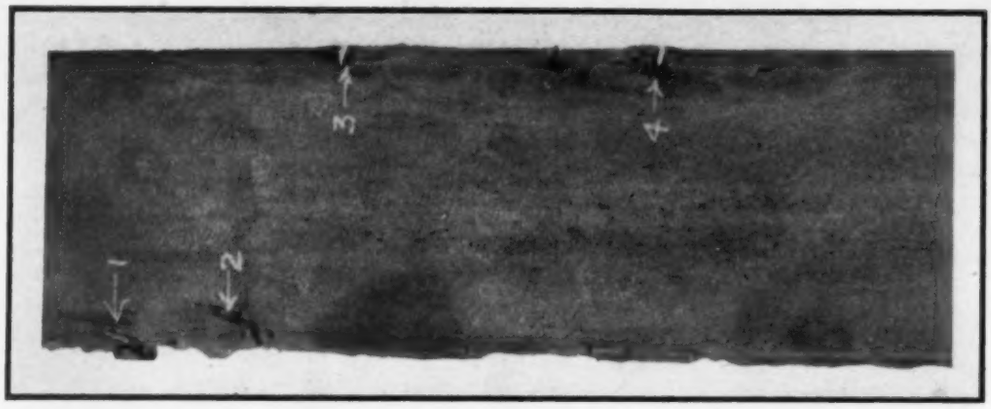


Figure 17—Photograph of macro-etched slab section revealing evidence of encrustment trapped in ingot skin while teeming. (top)

Figure 18—Photograph of macro-etched top cut slab section revealing large segment of encrustment trapped in ingot skin during teeming. (bottom)

ratio value is to unity the more favorable the rolling performance at the blooming mill. Judging from the trend defined by the curve in Figure 8 this Mn/C ratio provides a ready and convenient value for interpreting the condition of the refined metal.

The final phosphorous analysis directly reflects the slag conditions encountered in the refining operation. Here again the acidity from the charge silicon exerts a dominating influence. If an appreciable surplus of calcium oxide is not made available for completely neutralizing the oxidized phosphorous not only will the state of oxidation be kept on the low side thereby preventing good cleansing bath action but further additions of silicon to the bath through the silicon bearing alloys in the deoxidation period will result in a reversion of phosphorous from the slag back to the metal. Figure 9 shows the trend in the surface quality of semi-finished ingot products with increasing phosphorous analysis.

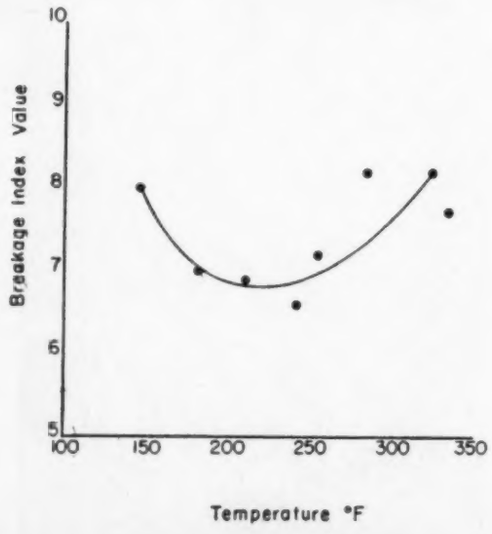
The early removal of phosphorous in the refining period not only indicates a favorable low charge silicon but also reasonably assures a good final phosphorous analysis. It also provides for that state of bath oxidation to develop which is found to be consistent with good cleansing action. The trend in the residual manganese also indicates the favorable removal of phosphorous. In showing the relationship between phosphorous removal and final phosphorous with residual manganese Figure 10 is of interest.

The influence of sulphur upon surface quality is so thoroughly established that little comment is necessary. Figure 11 confirms the findings of many studies.

Slag regulation for individual heats has been subjected to several methods of attack. The many studies made on the chemistry of slag formation have made it quite evident that the calcium oxide and silica contents are the controlling factors in the oxygen carried by the slag.

In the first slags formed during the oxidation of the scrap the iron oxide is quite high, as melting progresses with increasing metalloid content, FeO is continually reduced from the slag. This reduction in iron oxide from the slag continues until the heat is under cover, at which time, the pounds of iron oxide in the slag are generally at a minimum. The amount of FeO present at this point has a considerable bearing on the subsequent refining operation. The amount of iron oxide present at the low point in the melting operation is directly influenced by the total amount of oxidation up to that point, the total charge silicon and the amount of base in solution in the slag. These variables in their interrelationship suggest that the greater the oxidation the greater the tendency for lime to be taken into solution and therefore the lower the SiO_2 value of the

Figure 19 — Variation of ingot breakage with temperature of ingot moulds when dressed.



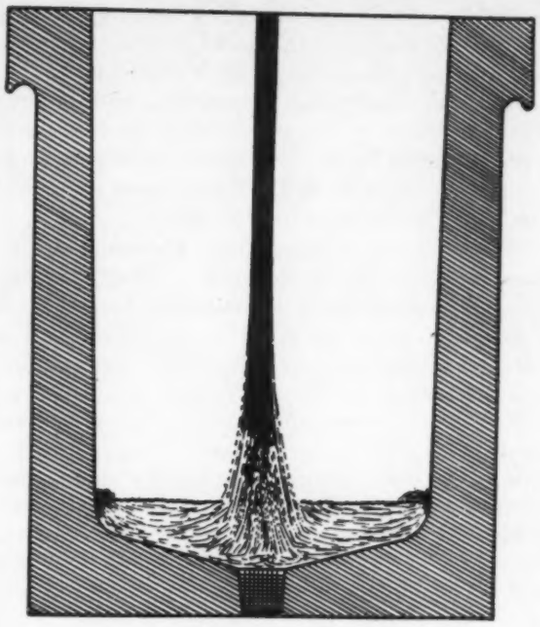


Figure 20 — Illustrating light action at the wall of a well prepared mould, preventing adherence of spatterings or encrustment.

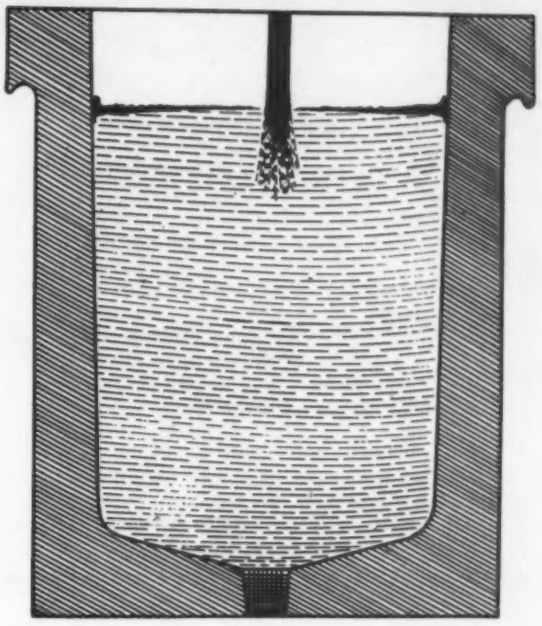


Figure 21 — Continued light action along the wall of a well prepared mould gives a good ingot surface.

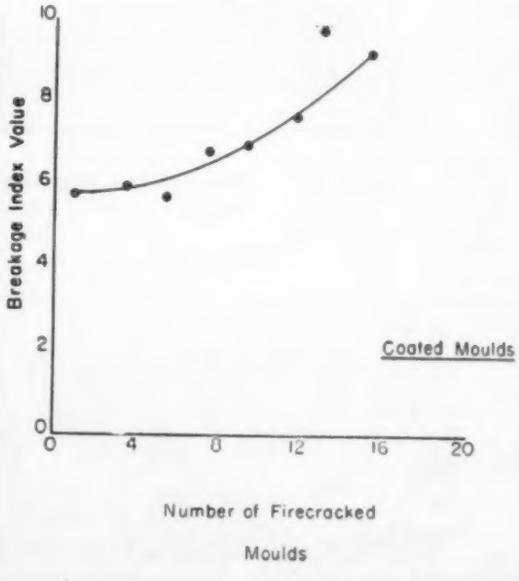
slag by dilution. It may further be stated that the higher the silicon content of the charge the less the available FeO for fluxing action.

Figure 12 on metal chemistry and Figure 13 on slag chemistry reveal the chemistry cycles on a heat of low carbon steel on which the total charge silicon was relatively high. In Figure 12 it will be noted that the residual silicon at approximately four hours after the molten metal addition is still .04 per cent. That a favorable state of oxidation does not start to build up in the metal until the residual silicon has dropped to .02 is verified by the FeO curve. Further, the slope of the phosphorous curve would be more sharply perpendicular if the total charge silicon were lower. In Figure 13 it will be observed that the low point in the oxidation cycle is around three hours after the hot-metal addition.

Figure 22 — Tabulation showing comparison of rolling performance of ingots poured in moulds with special dressing and in old salt dipped moulds.

Mould Condition	Ingot Temperature	Soaking Pit Temperature	Soaking Pit Number	Ingot No	Breakage B	Breakage M	Breakage T	Temperature Entering Mill	Temperature At 6" Pass
Moulds 1&2 used twice. Balance of group new moulds with Manufacturers Mould Dressing.	Dark Cherry Red	2100 °F	12	1	L	L	0		2070 °F
			12	2	L	L	L	2160°F	2070 °F
			12	3	0	0	0	2180°	2090°
			12	4	0	0	0	2145°	2040°
	Dark Cherry Red	1400°F	10	5	0	0	0	2190°	2010 °
			10	6	0	0	0	2155°	2075 °
			10	7	0	0	0	2150°	2050°
	Dark Cherry Red	1400° F	22	8	0	0	0	2135°	2040°
			22	9	0	0	0	2145°	2035°
			22	10	0	0	0	2140°	2040°
This Group all old moulds Salt Dipped.	Dark Cherry Red	2100° F	21	11	L	L	L	2155°	2070°
			21	12	M	M	M	2135°	2030°
			21	13	0	L	0	2165°	2045°
			21	14	L	0	0	2135°	2040°
	Dark Cherry Red	2110° F	17	15	L	M	L	2150°	2020°
			17	16	M	M	M	2130°	2020°
			17	17	H	M	L	2100°	2025°
			17	18	M	L	0	----	----
	Dark Cherry Red	1400°F	25	19	L	0	0	----	----
			25	20	0	M	0	----	----
			25	21	0	0	0	----	----
			25	22	0	M	0	----	----
				Average:				2142°	2045°

Figure 23 — Effect of firecracked moulds upon ingot breakage.



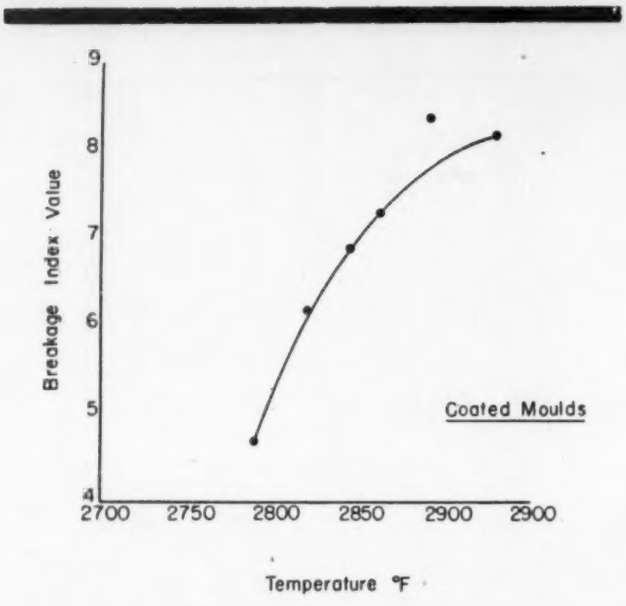


Figure 24 — Ingot teeming temperature vs ingot breakage.

This minimum state of slag oxidation not only occurs when the lime-silica ratio approximates unity but also corresponds to that time of maximum slag fluidity.

The value of controlled oxidation in the final finishing slags is well illustrated in Figure 14.

MOULD PREPARATION

The graphic illustrations already presented have clearly shown the advantage which may be gained in improved ingot surface quality by a well prepared ingot mould.

That good mould wall surface is a prime essential in the teeming of alloy steel can most readily be confirmed by brief observation of the steel rising in coated and uncoated moulds. In this operation an encrustment of deoxidation products and metallics forms on the surface of the metal rising in the moulds; this encrustment becomes entrapped on the rough inside mould wall contaminating the ingot skin. Figures 15 and 16 provide ready illustration of this condition. Figures 17 and 18 are photographs of macro-etched slab test sections which plainly show evidence of entrapped material and the nature of surface rupture resulting.

In Figure 19 it is shown that the required mould temperature for the application of the pitch mould dressing is around 250 F if maximum benefit is to be realized from this fundamental operation, and such temperature can only be accurately determined by actual measurement. Therefore, in a well ordered system for mould preparation, provision for pyrometric control must not be overlooked. When moulds are coated at too low a temperature the dressing cannot be applied uniformly; thus heavy action at the mould interface while the steel is rising will result in seamy surface and subsurface porosity. If moulds are coated at too high a temperature, the pitch dressing will be "cokey" and thus be totally ineffective from the standpoint of splash repulsion and other benefits. When moulds are dressed at the required temperature, their surface will be similar to bright, hard black enamel and will possess excellent properties in shedding the spattering of the steel against the mould walls. In a well prepared mould, the dressing will create a slight boiling action at the inside mould wall. This leads to a light rolling action in the molten metal at that location and effectively prevents the metallic encrustment from adhering to the inner mould wall surface. Figures 20 and 21 indicate the effect of this action.

The chart in Figure 22 very clearly reveals the differences observed in the rolling performance of ingots teemed into well prepared and unprepared moulds. Ingot moulds having a poor inner surface naturally are not conducive to good surface quality. Figure 23 clearly

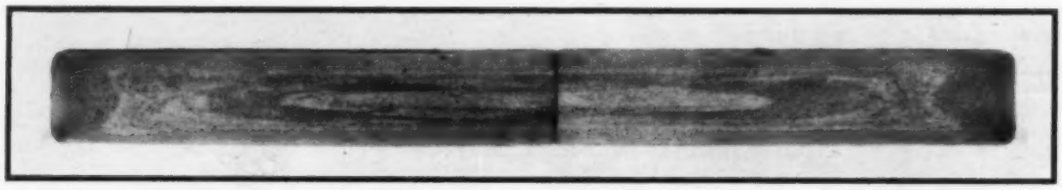


Figure 25 — Macro-etched butt cut from slab, revealing lack of homogeneity resulting from briefly interrupted teeming at butt of ingot.

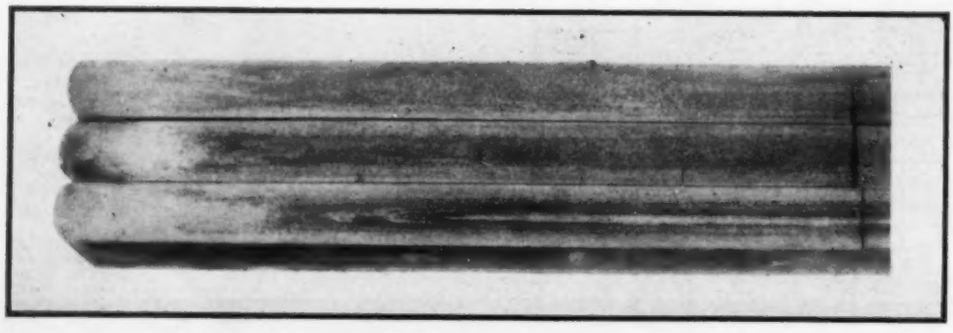


Figure 26 — Macro-etched rolled sections, showing result of lack of homogeneity caused by briefly interrupted teeming.

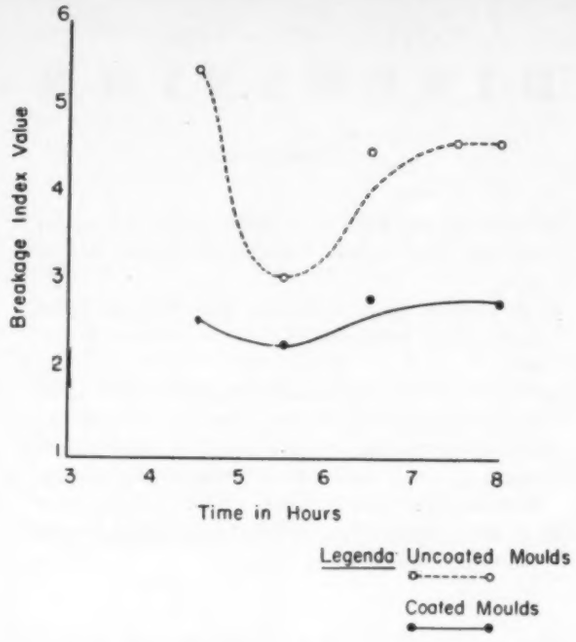


Figure 27 — Variation of ingot breakage with transfer time between teeming and charging. (above)

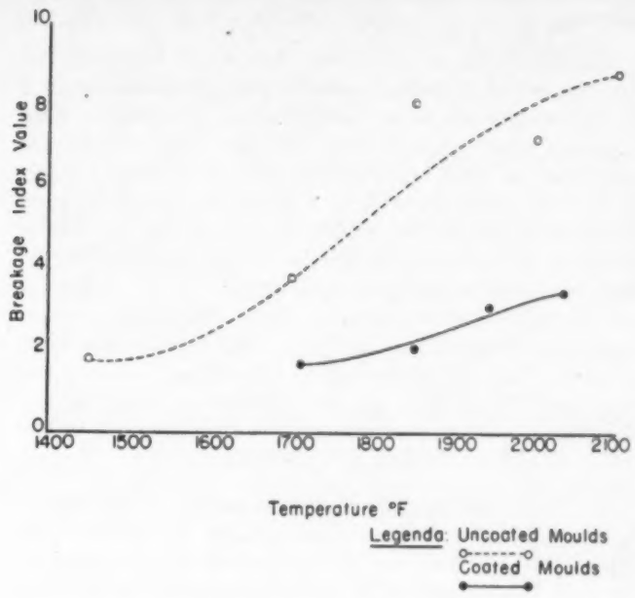


Figure 28 — Variation of ingot breakage with temperature of soaking pit when ingot is charged. (above right)

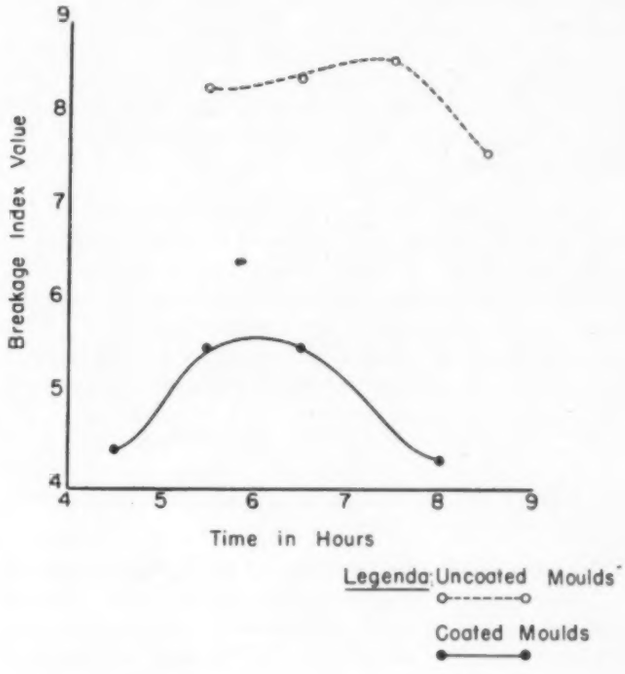


Figure 29 — Total heating time vs ingot breakage. (bottom right)

defines the trend in surface quality with increasing defectiveness of mould wall condition.

It is generally agreed that more good steel has been ruined in the teeming operation than in any other stage of the practice. An integral part of this operation is temperature of metal. While a reasonable range of variation in teeming temperature may not be particularly harmful to killed steel quality in general, teeming temperature does influence ingot breakage at the blooming mill. That hot pouring induces a coarser and structurally weaker primary crystallization which is more susceptible to breakage is well shown in Figure 24.

A brief interruption in the teeming operation of the lower portion of a killed steel ingot is very detrimental to the textural soundness of the ingot product. The pattern resulting from such practice is shown in Figures 25 and 26. Chemical examination of these sections found considerable variation in the chemistry between the sound and porous areas. This variation in chemistry naturally will also influence the uniformity of physical properties.

MECHANICAL HANDLING

Accurate information as to the time required for the complete solidification of any one ingot size is most essential to quality steel making. If alloy steels are moved too soon after teeming, while portions of the ingots are still in the initial stages of solidification, evidence of such early disturbance can usually be found in a macro-examination of the ingot product.

The depth to which transverse solidification has proceeded before big-end-up ingots are removed from the moulds is of very considerable importance. Should ingots be moved relatively early after teeming and withdrawn from the moulds at such temperature that the surface strength of the ingot is still relatively weak, any contamination of the ingot skin resulting from entrapped encrustment of deoxidation products (naturally being a pronounced plane of weakness) would be subject to slight rupture, which upon subsequent heating and rolling would develop into serious surface breakage.

The average time interval of ingot transfer from the finish of teeming to soaking pit charging for rectangular ingots of sizes ranging from 26 in. x 47 in. big-end-up

to 24 in. x 66 in. big-end-up was found to be around five and one-half hours. Figure 27 reveals such time interval.

The handling of any alloy steel ingot between the completion of teeming and the rolling operation is a matter requiring most careful attention as to time intervals and temperatures. If alloy steel ingots are permitted to cool too rapidly serious stresses are set up in the ingot structure. Should an ingot in such strained condition be placed in a soaking pit whose temperature exceeds considerably that of the external surface of the ingot, the rapid expansion of the outer surface will very frequently cause transverse surface rupture, particularly where ingot skin contamination is present. That the temperature differential between the ingot and the soaking pit into which it is being charged should be held to a minimum is well illustrated in the trend of surface quality in Figure 28.

The final unit operation preceding the actual rolling is the heating operation. This is the operation that completely controls the plastic nature of the ingot in the mill, thus it cannot be overemphasized. Fundamentally sound heating practice is that which embodies meticulous attention to the preliminary soaking, which in turn insures relieving the structural strains set up in cooling, and a well controlled gradual heating that will result in thermal uniformity throughout the ingot body some time previous to attaining that pre-determined temperature which permits of good plastic flow under the mill.

Partial explanation for the pattern described by the curves in Figure 29 may be found in a combination of three conditions: transfer time, ingot temperature at time of charging and temperature differential between ingot and soaking pit. If the transfer time is such that considerable temperature still remains in the ingot a heating time of around five hours will result in a reasonably good surface. If however, the temperature of the ingot body is quite low at the time of charging, a good saturated state of temperature which will result in favorable rolling condition is only attained after careful heating for 7 or 8 hours.

In a summarized evaluation of the foregoing data it is found that the effective improvement made possible through proper attention to mould preparation is around 37.0 per cent. In a sub-division of this figure by grouping the evaluated findings in each unit operation into raw materials, refining practices and mechanical handling it was found that the average difference in surface quality between heats poured into coated and uncoated moulds was:

26.0 per cent in furnace charge materials
35.3 per cent in refining practices
38.7 per cent in mechanical handling

These three values are of interest for the reason that the higher values indicate those operations requiring maximum attention.

Mould design and mill reduction being specialized phases of operation not in the realm of process metallurgy were not dealt with in this study but were assumed to be consistent with recommended practice.

DISCUSSION

PRESENTED BY

H. E. PHELPS, Electric Furnace Superintendent, Rotary Electric Steel Company, Detroit, Michigan

H. F. LESSO, Process Control Metallurgist, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan

L. R. MILBURN, Electrical Engineer, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan

PAUL CARNAHAN, Superintendent Steel Conditioning, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan

G. R. McDERMOTT, Vice-President, Surface Combustion, Toledo, Ohio

H. E. Phelps: I heartily agree with Mr. Lesso in his statement that the hard, black, shiny mould coating gives the best ingot surface. In fact, it is beautiful, but I would like to ask him if he ever encountered any difficulty from hydrogen with such a coating?

H. F. Lesso: Not to my knowledge.

H. E. Phelps: Relative to the graph on the maximum amount of light scrap to a charge, assuming two heats using the maximum and minimum amounts shown on the graph, if the two heats were finished to the same end point, that is, if both were equally deoxidized, would not the results be the same?

H. F. Lesso: I don't believe so, because, as I have described, the extent to which oxidation is carried on, or shall I more clearly state, the final oxidation resulting from or developing from the "low point" in the oxidation-reduction cycle, largely determines the type and extent of deoxidation practice necessary. The variability in the quantitative oxidation carried by the metal through the refining period is substantially influenced by the oxide value carried at the "low point," and this in turn directly influences the degree with which that oxidation value is attained which has been found to result in good cleansing action in the bath.

H. E. Phelps: Your end point has no bearing?

H. F. Lesso: No, sir.

L. R. Milburn: On low carbon steel, would it be as necessary to coat the moulds as it is on alloy steels?

H. F. Lesso: I subscribe one hundred per cent to a uniform practice in mould preparation, no matter what kind of steel you pour.

H. E. Phelps: What is your opinion of tar as a mould coating?

H. F. Lesso: Tar isn't quite as good as pitch. I think in our experience we have found that the pitch dressing can be applied more uniformly and with a minimum film thickness, at a reasonably favourable operating temperature. This mould temperature as shown in Figure 19 was found to be between 240 F and 250 F in our mould system.

Paul Carnahan: I would like to ask a question concerning the definition of the term breakage as it was used in determining values. Would you define the word "breakage" as you have used it tonight a little more clearly to me?

H. F. Lesso: Breakage, of course, is a surface rupture of variable depth and variable length, the evaluation of which can only be made by subdivision of the linear dimensions of the ruptures. Through metallurgical observation it has been possible to set up relative evaluations of these breakage patterns, which have served as a reasonably reliable indicator of surface conditions. The breakage to which I have referred has been that which has had not only considerable length, but also considerable depth (i.e., the serious type of surface rupture). Regarding the linear features of the breakage, that which has been from 10 inches to several feet in length has been considered in this study.

Paul Carnahan: These breakage points, I presume, are all taken from visual observations at the blooming mill?

H. F. Lesso: They were evaluations of breakage based upon a great number of observations made during rolling operations. We have found a sub-division of this breakage into light, medium, and heavy groupings to be suitable for our metallurgical purposes.

G. R. McDermott: In heating alloy steels, is it desirable to have a time-temperature control of the ingot up to the lower critical temperature?

H. F. Lesso: I think that the temperature of any ingot body, no matter what type of alloy steel it may be, should be considered when charged into any reheating unit, and that such temperature differential be a minimum. By holding such temperature differential to a minimum, you compensate for other operating variables which you may encounter, and by so doing you reasonably insure freedom from surface or internal ruptures which may result from structural strains set up during solidification.

G. R. McDermott: Considering soaking pit heating, would that be reflected in the percentage yield on the ingot?

H. F. Lesso: That would be determined where you were going to set up your unit values. If you have an ingot which has rolled out with a serious condition of breakage in the butt portions or the top portions, and the rupture or ruptures are of such nature as would result in prohibitive resurfacing cost, it would be more expedient to cut it out in your croppage than spend considerable money in trying to reclaim it. In that way your surface breakage would influence your ingot yield. If soaking pit operations are such as would result in ruptured ingots due to excessively high temperature at the time of charging, or if such heating operations should result in surface burning, then of course soaking pit operations would be directly reflected in ingot yields.

H. E. Phelps: Would heating operations in the soaking pit be reflected in the discard from slab?

H. F. Lesso: As previously stated, providing such operation in the soaking pit resulted in a more defective ingot product, and these defects were sufficiently serious to compel selective shearing of the ingot product, thereby increasing the croppage loss, then your heating operation would be reflected in the discard of the slab product.

G. R. McDermott: Would you have any beneficial result in preheating the mould?

H. F. Lesso: Definitely, to a temperature of 250-300 F.

H. E. Phelps: Our track time averages about 1¼ hours on a 17 inch ingot. What is your opinion on that?

H. F. Lesso: I would say that 1¼ hours on a 17 inch ingot would be sufficient time. I think you could reasonably hold an ingot of that contour to an hour.

Member: How soon after teeming or at what temperature should the ingots be sent to the soaking pits?

H. F. Lesso: At such time as will insure complete solidification and at such temperature as will permit handling without damage to the internal or surface ingot structure, also with the view to maintaining operations as will permit of efficient movement of material and maximum use of equipment.

Paul Carnahan: In Figure 29, dealing with the soaking pit time you showed a maximum of plasticity after about four and a half hours, then it leaves off and goes up, and you again reach about the same degree of plasticity at the end of eight hours. Could you make that a little more clear?

H. F. Lesso: In attempting to analyze the pattern as shown in Figure 29, a number of operating conditions must be considered: transfer time, temperature differential between the ingot and the soaking pit into which it is charged and total heating time. Of these, the transfer time, of course, directly affects the residual heat in the ingot, the ingot body temperature in turn influencing the initial pit operation, which brings into focus the temperature differential between the ingot and the pit, and finally, the combined influence of these two operating features which directly control the total heating time. The multiplicity of variables in the heating operation, of course, also contributes to the pattern of the curve; however, as was stated, if the transfer time is such that the ingot body temperature is still quite high, and if the ingot is of sound skin structure, reasonably favourable rolling performance will result with a five hour heating time. Should, however, the transfer time be such that the ingot body has cooled to a very low temperature, a good plastic flow of the metal does not again develop until the heating time has been of seven to eight hours duration.

G. R. McDermott: May I ask what type of alloy steel you refer to?

H. F. Lesso: It is low alloy steel, essentially of the high strength type. They come within a certain category, approximately .25 carbon, .75 or .85 manganese, and .50 to .65 silicon, and approximately the same range of chromium, etc.

H. E. Phelps: Have you found much variability due to nozzle size?

H. F. Lesso: In our experience, we have used essentially one size nozzle in our teeming operations, so I haven't any information on variations in surface condition with various sizes of teeming nozzles.

Industrial Engineering

IN WAR PRODUCTION

. . . . ultimate productive speed comes only from the combination of the best mechanical methods and the maximum cooperation of every worker . . . . industry can plan the first . . . . the second requires a selling job . . . .

by C. P. Spangler

INDUSTRIAL ENGINEER

JONES AND LAUGHLIN STEEL CORPORATION

PITTSBURGH, PENNSYLVANIA

▲ INDUSTRIAL engineering, as we know it, began with the work of Frederick W. Taylor of the Midvale Steel and Ordnance Company, who expounded certain principles in his paper entitled "A Piece Rate System: Being a Step toward the Partial Solution of the Labor Problem," this paper being given before the American Society of Mechanical Engineers in 1895, and in his book on "Shop Management" published in 1911, followed by the work of Harrington Emerson of the Santa Fe Railroad, who later founded the firm of consultants, the Emerson Engineers, and published two books entitled "Efficiency" and "The Twelve Principles of Efficiency" in 1908 and 1911. These men were followed by many disciples who devised mechanical methods of labor saving, taught men how to save their own labor and to accomplish more, and devised wage incentive plans to encourage them to do so and to offer additional earnings to attract good workmen and still reduce labor cost.

Previous to the present war, industrial engineering in the steel industry became stabilized into a process mainly of devising improvements in planning routing and handling of materials, studying means of reducing delays in the operation of equipment and of processes, setting standards and wage incentive for human efforts, and establishing budgets and cost control methods. Mechanical and mathematical methods, the tools of the engineer, predominated and were the technique of industrial engineers of the pre-war era.

But war hit us over night on December 7, 1941. Germany had been preparing for war for 10 years and Japan started preparing 20 years ago. We had to do in a year or two what our enemies had already accomplished. From our government came the demand for production and more production, steel and more steel. From the army which was sacrificed at Bataan came the cry "Too little and too late." We were caught as we have been caught at the beginning of all of our previous wars — unprepared. Though it has nothing to do with my subject, I must mention that the occurrence at Bataan, the unpreparedness, is a terrible blot on the pages of our history. We who are veterans of the last war hoped fervently after that war that America would learn a lesson from the total lack of preparedness of 1917, but it still seems to be true that the main thing that we learn from history is that men will not learn anything from history.

With the quick expansion into an industrial war effort, the skilled labor pool was quickly dried up. Men are still being taken from industry to man our armed forces. We are faced with a production speed problem as well as a drain on our manpower. War production goals and the monthly patterns of the War Production Board were set beyond the reach of available mechanical methods. In 1942 the steel industry broke many

Presented before A. I. S. E. ANNUAL CONVENTION, Pittsburgh, Pa., Sept. 28-30, 1943

records to produce 86,000,000 tons and the War Production Board first asked for 92,000,000 tons for 1943. Ultimate speed of production can come only from the combination of the best mechanical methods and the maximum cooperation of every man and woman in the mills.

In war times, the first part of this problem — the mechanical problem — is still somewhat the same as it was in peace times, consisting of methods, planning, routing, handling, cost control, etc. But the difficulty of obtaining new pieces of equipment, the time lost in making mechanical changes, has made it most urgent for us to get the best production out of what we have. So it has become most important to study the problem of the utilization of equipment to the fullest extent with the least delays. This is particularly important on equipment which may turn into bottle necks and restrict the production in succeeding processes. Hence detailed studies of delays are required in order to diagnose the illness before trying to write the prescription for the cure. Delays of small duration, and some of large duration, are so often taken for granted that they are not noticed, until a detailed study throws light upon them. For example, the shutting down of open hearth furnaces for repairs when parts of the furnace have burned away and collapsed has been taken for granted since open hearths were first built. It has just been assumed that this is a natural sequence in open hearth operation. Recently several steel companies have had their industrial engineers make detailed analyses of this problem and have learned that scheduled repairs in an orderly rotation — instead of waiting for furnaces to fall in at a time when the operating rate is rapidly declining — will increase the furnace availability time, hold up a higher average operating rate and result in a worthwhile annual tonnage increase. It is sometimes difficult to make the open hearth management see, when production is paramount, that it is false economy to try to get the last day's or week's operation out of a furnace before taking it off for rebuilding. But the cost of continued patching to keep it going, coupled with the decreasing operating rate of a dying furnace, has an effect on operating cost and on production that can be likened to the working of the old economic law of diminishing returns.

On a blooming mill rolling 200 ingots per turn, a saving of one second on the time between ingots or on the manipulating time of each ingot means an additional 1.4 ingots rolled per turn. With 10 ton ingots and assuming only 300 operating days in the year, the annual production would be increased 12,600 tons — by just saving one second of time per ingot. Studies of ways and means of accomplishing such schemes for increased tonnage have become a major war time problem of the industrial engineer.

The second part of the previously stated problem, "the maximum cooperation of every man and woman in the mills," is a job in personnel relations and must be faced by the industrial engineer in close cooperation with the operating management. The industrial engineer has a new factor added to his previous job which he must successfully consider if he expects to accomplish the maximum possibilities from his efforts. It is a personnel job which is outside the function of the personnel department. The various wage incentive plans and the methods of deriving them have not changed, but making them work to produce the best results has changed. It is no longer sufficient to be just sure of the mathematics involved, getting the approval of the operating management and explaining the scheme to the men concerned. The men must be completely sold on the plan to the point of enthusiasm and the union must be convinced that the plan offers something to the men and is not a speed-up scheme in disguise. Management-labor committees, as sponsored by the War Production Board, are probably here to stay and we must get used to dealing with and through labor representatives if we are going to attain the maximum cooperation required to meet war production demands. The industrial engineering department must realize its position in the personnel problem, and become conscious of industrial relations. This selling job is of great importance today because many new employees, including women, have come into the steel industry, who have not been educated in the pre-war steel mill school of a full day's work prompted by initiative, interest and respect for foremen's orders. The War Labor Board has given its approval to wage incentive plans, but getting the best results out of them is a personnel problem. Also, as Glenn Gardiner reminds us in one of his recent bulletins, since the word has gone out that federal authorities look favorably upon wage incentive systems that will increase production, many workers will grab on to this idea and claim that this is a way for companies to increase their wage earnings. It is not quite as simple as this, however. The installation of a wage incentive system, where no wage incentive system was in existence before, must have the approval of the War Labor Board, which will only approve such a system if it is demonstrated that the unit cost of production is not increased and that the system tends to increase the amount of production. No good can be accomplished merely by a "handout," even though we call it an incentive system.

Labor's sensitiveness to pay rates and to differentials between rates for various jobs has brought job evaluation to the front. Job evaluation, a method of arriving at basic pay differentials between various occupations in the plant on a basis more nearly correct than the differentials usually in existence, is an industrial engineer's problem and one which needs much study. It also helps set up a sound system of job progression, thus eliminating the cause of many discussions with the union about channels of promotion and seniority rights.

The personnel department is very busy these days trying to meet the manpower shortage, recruiting men and women to take the place of the men who have gone into the armed services, dealing with the draft boards on deferments, manning tables and replacement schedules, induction programs for new employees, safety programs for the new men, and especially for the women, who are not mill-minded. The problem of training new employees quickly to get them into production, of holding them on the job during and after training, and of training foremen to be good teachers and good handlers of people is a natural function of the personnel department, but this department is almost too busy to give any thought to it. It is, however, a problem which cannot

(*Please turn to page 82*)

A. I. S. E. Standard Designs

FOR CRANE SHEAVE WHEELS

by F. W. Cramer, CHAIRMAN

A. I. S. E. CRANE COMMITTEE

Sub-committee on sheave wheels:

D. W. O'Leary, Bethlehem Steel Company.

R. W. Steigerwalt, Carnegie-Illinois Steel Corporation.

W. L. Poto, Alliance Engineering Company.

S. R. Cox, Morgan Engineering Company.

H. W. Ball, Morgan Engineering Company.

E. L. Anderson, Bethlehem Steel Company.

William Mursch, Carnegie-Illinois Steel Corporation.

W. C. Heinle, Cleveland Crane and Eng. Company.

C. S. Shephard, American Bridge Company.

W. A. Aston, Carnegie-Illinois Steel Corporation.

N. Pochner, Bethlehem Steel Company.

J. T. Bradford, Jones and Laughlin Steel Corp.

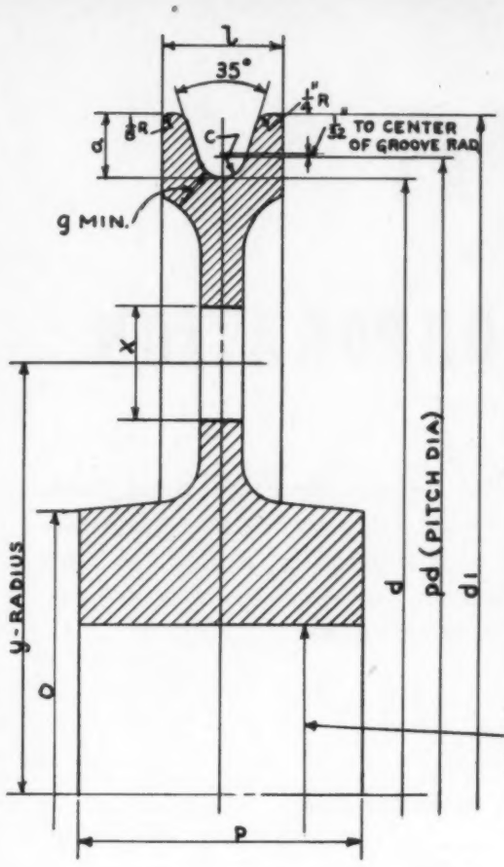
H. J. Walters, Jones and Laughlin Steel Corp.

I. N. Tull, Republic Steel Corporation.

▲ CARRYING on its standardization of cranes and crane parts, the Crane Committee of the Association of Iron and Steel Engineers has completed work on the design of rolled steel sheave wheels and the recommended standard designs are shown in the accompanying sketches.

In determining the recommended standard designs, consideration was given to the following items:

1. A study of the rolled steel sheaves ordered by the crane manufacturers and users during the past two years.
2. Paragraph 27-A of the A. I. S. E. Crane Specifications: "Sheaves shall be bronze bushed or provided with antifriction bearings, as specified, and have finished grooves of a depth at least 1½ times the diameter of the rope."
3. Paragraph 27-B: "The pitch diameter of all sheaves, except equalizer sheaves, shall not be less than 30 times the diameter of the rope used. They shall be enclosed by guards which fit close to the flanges so as to prevent the ropes from coming out of the grooves."
4. The following recommendation from the U. S. Master Specifications for Wire Rope:
   "The tolerance of the groove diameter should exceed the nominal rope diameter by 1/16 in. The slope of the groove was determined to be 35 degrees."
5. The available dies in manufacturers' plants for the larger sizes indicated that the large sheaves for 7/8 in. and 1 in. rope could be made from the same dies as the smaller sheaves for 1 in. and 1⅛ in. ropes.
6. The holes in the web are of greater importance as a means of handling the sheave than for reducing the weight. The manufacturers were requested to determine the size of holes in keeping with good shop practice and the committee decided on four holes per sheave.
7. The hub diameters shall be sufficient to house the largest antifriction bearing that has been specified for this size of sheave.
8. The pitch diameter rather than the tread diameter shall be used as the reference to size.
9. The rough bore diameter shall be specified by the customer.
10. The only part of the sheave requiring close machine work is the groove. The proper tolerance and finish for this will be determined by the Technical Board of the Wrought Steel Industry.
11. These designs are based on the use of 6 x 37 crane

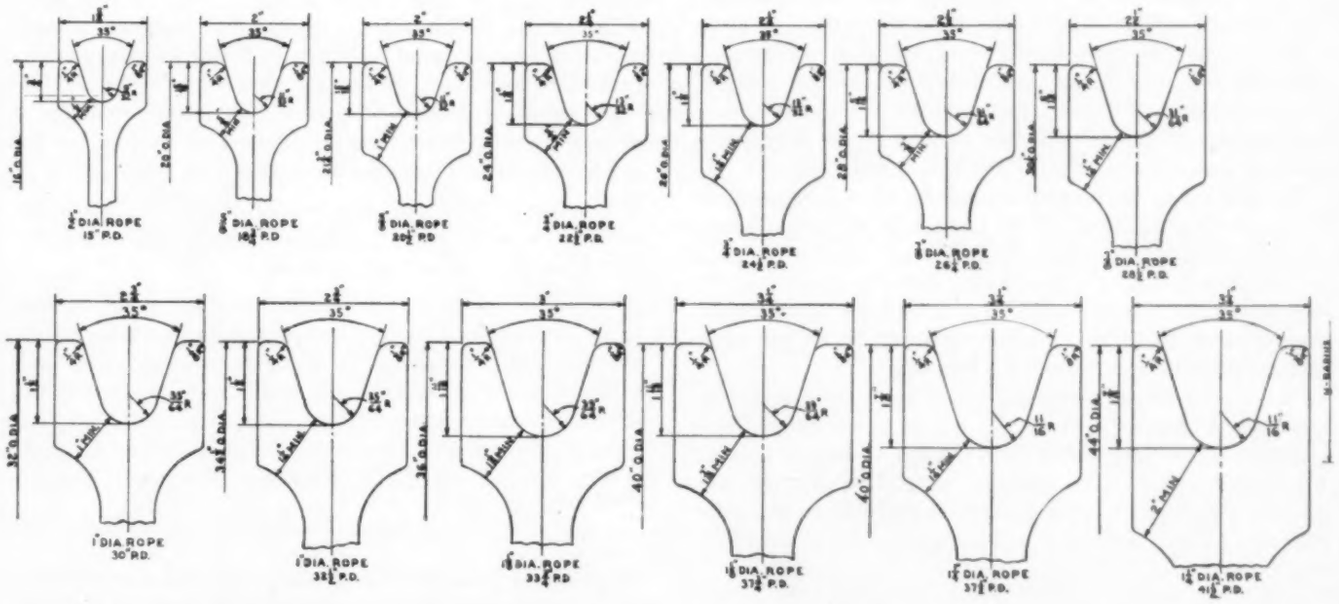


DIMENSION	WHEEL CLASS - A.I. & S.E.												
	S 15	S 18¾	S 20½	S 22½	S 24½	S 26¼	S 28½	S 30	S 32½	S 33¾	S 37¾	S 37½	S 41½
ROPE SIZE	½	⅝	⅝	¾	¾	⅞	⅞	1	1	1⅛	1⅛	1¼	1¼
a	¾	15/16	15/16	1⅛	1⅛	1 5/16	1 5/16	1½	1½	1 11/16	1 11/16	1⅞	1⅞
c	9/32	11/32	11/32	13/32	13/32	31/64	31/64	35/64	35/64	39/64	39/64	11/16	11/16
d	14½	18⅛	19⅞	21¾	23¾	25⅜	27⅝	29	31½	32⅝	36⅝	36¼	40¼
d1	16	20	21¾	24	26	28	30¼	32	34½	36	40	40	44
pd	15	18¾	20½	22½	24½	26¼	28½	30	32½	33¾	37¾	37½	41½
g	½	⅝	1	¾	1¼	⅞	1¼	1	1¼	1⅛	1 7/16	1¼	2
l	1⅝	2	2	2¼	2¼	2½	2½	2¾	2¾	3	3¼	3¼	3¼
o	8	9½	9½	11	11	13	13	14	14	15½	15½	15½	15½
p	4	4¾	4¾	5	5	5½	5½	5½	5½	5½	6	6	6
No. WEB HOLES	4	4	4	4	4	4	4	4	4	4	4	4	4
x	1½	1½	2	2	2	2½	2½	3	3	3	3	3	3
y	5½	7	7¼	8¼	8½	9½	10	10¾	11¼	12	12¾	12¾	13¼

ropes. On those cranes using 6 x 19 ropes, the manufacturers recommend a tread diameter of approximately 45 times the rope diameter.

The designs for these standard sheaves were submitted to the chairman of the Wire Rope Engineers Committee for comment, and in accordance with his suggestions, certain changes were made in groove dimensions to meet the standards of his association. Thus, the resulting work is in accord with the standards of the Wire Rope Engineers Committee.

The sketches show the cross sections and principal dimensions for the 13 standard sheaves adopted by the A. I. S. E. Crane Committee. The sheaves are for 6 x 37 ropes in sizes from ½ in. to 1¼ in., inclusive.



THE *Fuel Systems* AT GREAT LAKES STEEL CORPORATION

. . . . with oil as the principal fuel, mixed blast furnace and coke oven gas is automatically added to the open hearth furnaces as the supply exceeds other needs . . . .

by F. C. Frye, SUPERINTENDENT
STEAM AND FUEL DEPARTMENT
GREAT LAKES STEEL CORPORATION
ECORSE, MICHIGAN

▲ OIL was selected as the primary fuel for open hearth, billet, and slab reheating furnaces when the Great Lakes Steel Corporation's plant was built in 1929. The soaking pit's furnaces were the only heating units using another fuel, being arranged for producer gas operation.

The design and arrangement of the fuel oil supply system was one of major importance, so that no serious interruption in the fuel supply would be encountered and the large amount of fuel oil would be very economically distributed to the various furnace units.

In 1938 upon the completion of the blast furnace and coke oven installation, there was made available large quantities of mixed blast furnace and coke oven gas, which then became the primary fuel for open hearth and reheating furnaces. It was necessary to revamp and expand the fuel systems in order to utilize this mixed gas in conjunction with fuel oil.

At present we are receiving oil by boat, from where it is pumped either direct to the Great Lakes Steel Corporation's two 600,000 gallon storage tanks or to the Fuel Oil Corporation's storage tank farm. Under our present contract it is necessary to maintain a definite supply of oil in our storage tanks, insuring a sufficient reserve supply at the tank farm, to cover our fuel requirements during the closed navigation season. We take oil from this tank farm as required, through a connecting pipe line which is approximately one mile long, to the plant storage tanks. Our fuel oil storage capacity is estimated sufficiently large to supply the fuel oil requirements in conjunction with mixed gas for approximately a ten day period. This storage capacity prevents any interruption in the fuel oil supply due to failure of source of supply from the tank farm.

We have provided further insurance against the possibility of interruption by installing equipment to handle and store fuel oil received by rail.

Oil is taken from the 600,000 gallon storage tanks through a 12 inch line to the pressure pumps for plant distribution. The pumps, oil heaters, meters, valves and piping are the primary portion of this fuel oil system. The secondary element of the system is made up of a piping arrangement for unloading oil received by rail. There is a 25,000 gallon tank which receives the oil

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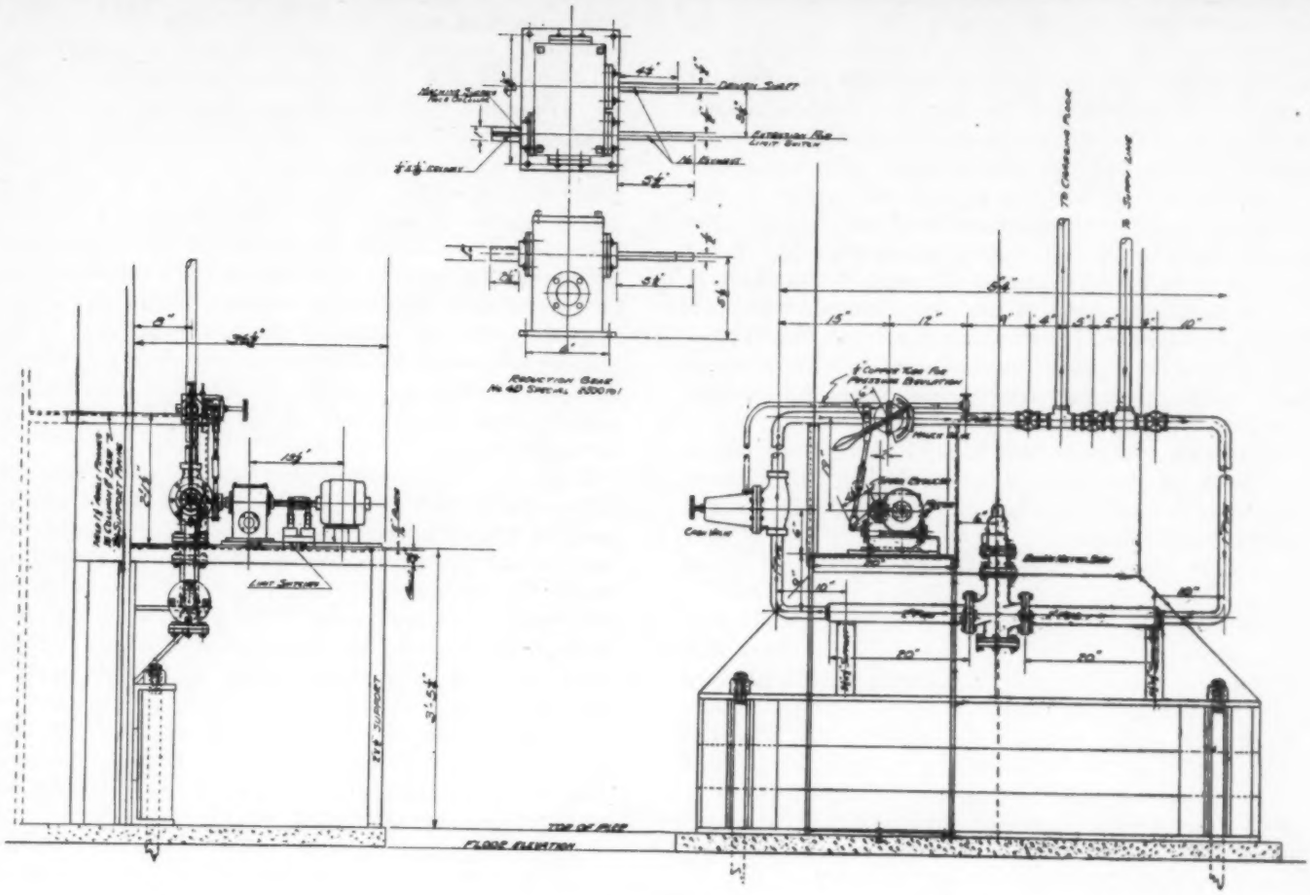
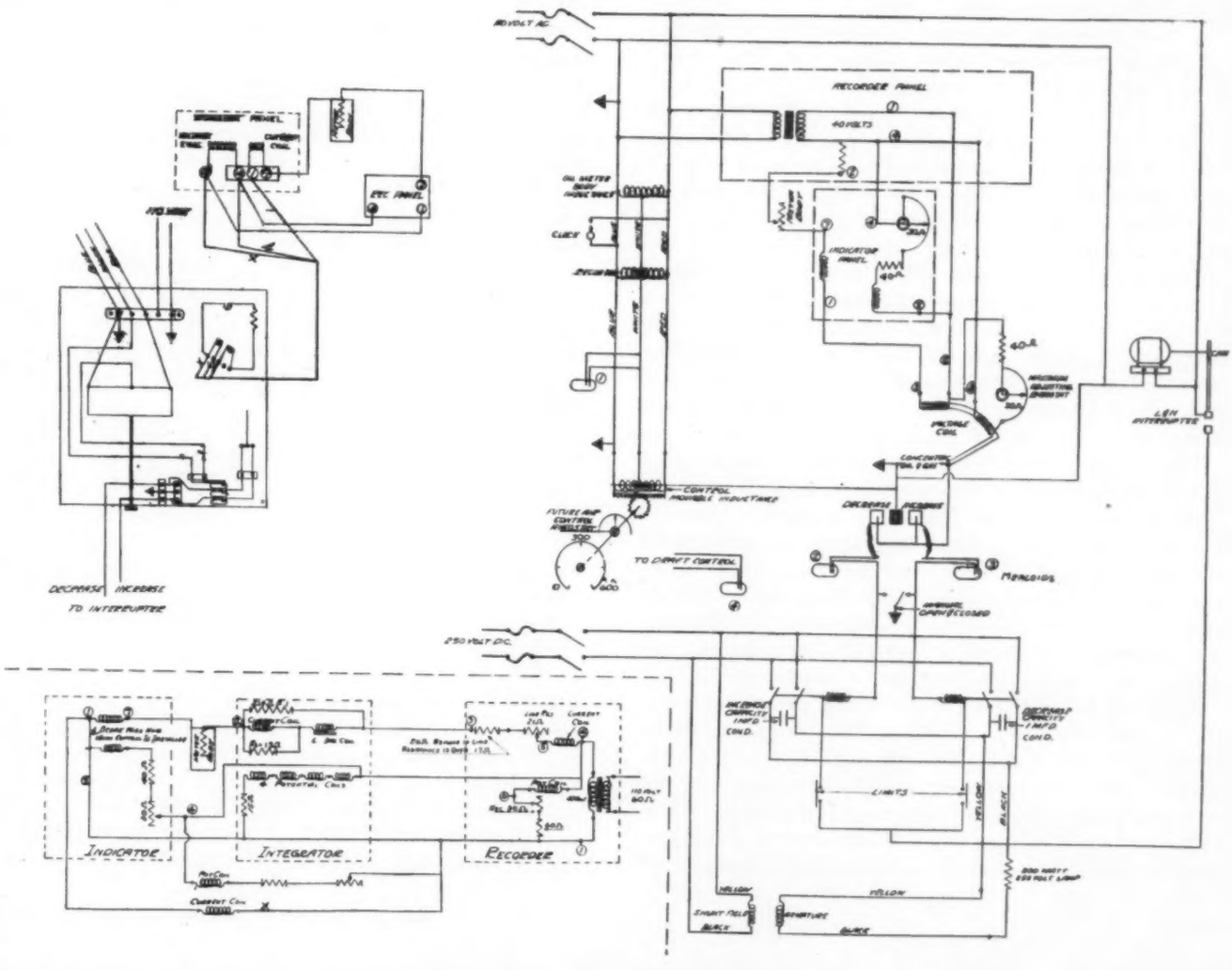
Sketches on opposite show valves and piping arrangement for ratio control (above) and simplified wiring diagram for oil and gas control (below).


REDUCTION GEAR
LIMIT SWITCH
TOP OF PILE
FLOOR ELEVATION


440 VOLT AC
RECORDER PANEL
40 VOLTS
INDICATOR PANEL
CONTROL HANDLE INDUCTANCE
TO DRAFT CONTROL
DECREASE
INCREASE
TO INTERRUPTER
250 VOLT DC
INDICATOR
INTEGRATOR
RECORDER
LIMITS
YELLOW
BLACK

from tank cars. The oil is then transferred by pump to the 600,000 gallon storage tanks.

Our main pumping station is arranged with a system of control valves and individual pipe lines to supply oil under automatic control to our No. 2 open hearth department. This system consists essentially of a pressure regulating valve at our main fuel oil pump house. It permits fuel oil to be pumped over to the storage tank at the No. 2 location, without endangering the supply going to our No. 1 open hearth department and to various re-heating furnaces throughout the plant.

The rapid expansion of our plant from 6 to 16 open hearth furnaces, each with an average tap of 220 tons, and the construction of numerous re-heating furnaces has demonstrated the correctness of the initial installation for the fuel oil system.

In conjunction with this fuel oil supply, the piping and equipment was designed to handle the heavier bunker C fuel oil which has an analysis under average conditions as follows:

Viscosity	236 sec at 210 F Saybolt universal 1035 sec at 100 F
Flash point	280-300 F
Fire point	340-360 F
Sulphur	Under ¾ of 1 per cent
Cold test pour	Plus 25-50 F
Btu per gal	154,000
API at 60 F	13.6

Due to present emergencies, the API gravities of the fuel oil have been increased up to 22 API at 60 F, which consequently reduces the heating value to approximately 146,000 Btu per gallon and increases the other evils in the fuel oil.

A main recirculating supply system was installed to handle the heavier and more viscous oils. The piping system consists of a six inch supply main for the outgoing oil from the pumping station, and a four inch line for the return. These pipes leave the main pump house through a pipe tunnel which connects with No. 1 open hearth building. Pipe sizes, pumping and heating capacities were based on 33 per cent of the recirculation of the oil in the main system.

An extremely flexible oil piping system was installed in the main pumping station. Pumps and heaters were selected of sufficient capacity to meet normal requirements with ample capacity for stand-by units. The pump house, piping, pumps and heaters are so arranged that anyone or all of the units can be placed in services as required.

The viscosity of the oil can be raised by pre-heating and the capacity of the pipe system is dependent on the viscosity of the oil and the initial pumping pressure. The pre-heaters, automatic temperature controls, pump and pressure controls were selected within such range as deemed necessary to economically handle the oils available. The pre-heaters were installed with temperature controls and have a capacity to maintain the temperature of the out-going oil to furnace within any range from 90 F to 200 F. The pumps and pressure controls are of such capacity that they will maintain an initial pressure within the range of 100 to 175 psi. Steam driven recirculating pumps are used for this service primarily because they can handle oils of widely varying viscosities and blend themselves to automatic pressure as well as capacity control. These pumps were installed with automatic pressure control, over speed governors, and as an added feature, the addition of a relief valve was installed in the discharge of each pump.

In order to secure the proper atomization of the fuel oils available, heating and pumping equipment was installed at each furnace unit throughout the entire plant. By dividing the heating and pumping of the oil into two stages, the most flexible system is provided and is capable of handling not only the heavy oils but also the lighter oils. The separation of the system into two stages also permits each furnace to be supplied with fuel oil at most satisfactory pressure and temperature for economical operation of the particular unit. This procedure also involves a considerable saving in power and heating costs, as only that oil is heated and pumped at a required temperature and pressure for respective furnaces.

A group of two pumps and heaters were installed between each two open hearth furnaces. The arrangement of piping is such that either one or both of the heaters and pumps may serve one or both of the furnaces. The arrangement of piping also provides for a recirculation of approximately 5 per cent of oil pumped through the heaters. The essential parts of this second stage oil units consists principally of two oil heaters with temperature control each having a capacity to heat 1000 gallons of oil per hour. It also includes two steam driven reciprocating pumps with pressure controls of equal capacity and capable of maintaining an initial oil pressure of 150-300 psi.

A suitable receiving storage tank for reheating furnaces from the supply line through a float regulating valve maintains a fixed level of oil in storage tanks for furnace operation. Each of these systems consists essentially of a vented receiving storage tank, electric driven rotary pumps, pre-heaters, meters and necessary regulating valves and piping. In each system, provision was made for re-circulation. The pumps and heaters were selected to maintain the pressures and temperatures required for the proper atomization of the oil in the respective burners. In each installation provision was made for stand-by heaters and pumps in order to provide insurance against any possible interruption of service due to the failure of this equipment. Also, the capacity of oil storage tanks was determined so that any temporary interruption of the main oil supply system will not interfere with continuous operation of these various furnaces.

Throughout the main supply and individual furnace fuel oil systems, a complete installation of meter equipment was provided. Meters were installed to record total amount of oil pumped from the main pump house and each individual system was also provided with meters to record the amount of oil consumed at each individual furnace.

We have found it necessary in the past few months to resort to a fuel oil treatment in order to keep storage tanks clean and free from precipitation as well as breaking down inhibited water in the oil itself. This chemical treatment reduces the surface tension of the molecular structure within the oil itself, thus freeing any water particles and also assists in the burning of the fuel due to pre-heaters, piping, pumps, strainers, and burners being kept clean. This is a direct advantage in that it eliminates necessary labor in the maintenance of keep-

ing this equipment clean and in first class operation. It is also a preventative in building up sludge forms and carbon accumulations. The low cost of this treatment is adequately being returned in an overall operating efficiency inasmuch as its use eliminates the necessity of cleaning tanks, pre-heaters and the physical labor which otherwise would necessarily be involved. We are adding this treatment in the fuel oil storage tanks, using approximately one quart per thousand gallons.

After several months of using mixed gas in our plant, we found it necessary to resort to an automatic mixed gas dumping control for open hearth furnaces. This control was made necessary to stabilize the plant gas pressure system, due to the fact that the flow of gas varies from hour to hour depending on departmental furnace conditions which have preference of gas usage. This unloading or dumping control is in principle a pressure instrument and is connected to the main gas line so that when gas pressure increases above a set point (approximately 60 inches of water) an air impulse pressure is sent out to all open hearth furnaces. This air pressure is connected to a graduated air cylinder and in turn to butterfly valves on the gas line to each furnace. All gas valves open approximately the same amount. As gas pressure increases the butterfly valves open wider in proportion. Due to the fact that the gas flow increases and decreases, it is necessary that the oil be also increased or decreased in proportion to the Btu equivalent so that it will hold the total Btu input at a constant amount.

This flow of gas is measured by means of an orifice and electric meter which in turn converts the pressure drop across the orifice into a straight line characteristic, which represents flow of gas or Btu per hour.

The principle of oil regulation in this control is regulated by a set of electric contacts placed on either side of the scale pointer, representing oil flow. If the oil flow increases one contact causes the electric oil valve to close slightly or until the contact is broken. The action is reversed on the decrease in oil flow. So in order to correct for an increase or decrease in gas flow, the position of the contacts are shifted to the correct amount by connecting them to the gas flow indicator. By this process, the total Btu input to the furnace is held to any particular point which is determined by the first helper. The oil valve motor control contacts actuate the relays which operate the motor valve in either direction, as the control calls for more or less fuel oil. In order to stop hunting action, an interrupter is used in the control circuit. To prevent trouble on low oil flows, where the valve is in critical position, a differential pressure valve is introduced to hold an approximately constant pressure drop across the oil control valve. From a mechanical standpoint, the control box is a separate instrument. It comprises a gas flow indicator and an oil flow indicator which are both connected electrically with their respective oil and gas flow recorders. The proper contacts for operating the oil valve are located in this box together with a large dial and pointer on the front of the box for setting the heat input.

The Great Lakes Steel plant fuel system described in this paper has been most successful since the first installation thirteen years ago.

DISCUSSION

PRESENTED BY

A. J. FISHER, Fuel Engineer, Bethlehem Steel Company, Sparrows Point, Maryland

F. C. FRYE, Superintendent Steam and Fuel Department, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan

J. F. WILBUR, Superintendent Steam and Combustion, Bethlehem Steel Company, Johnstown, Pennsylvania

P. F. KINYOUN, Combustion Engineer, Bethlehem Steel Company, Lackawanna, New York

C. J. WYROUGH, Superintendent Steam Efficiency and Combustion, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania

A. J. Fisher: I would like to know something about the chemical treatment which is put in the oil, a little more about the physical characteristics of it, and how much it costs per gallon of oil?

Also, why is the gas put in all the furnaces at one time, instead of putting it in one furnace at a time? What is the reason for putting a little gas on all the furnaces at one time, rather than loading up one furnace at a time or selective loading.

F. C. Frye: We are using a chemical treatment which is made in Pittsburgh, Pennsylvania and Canton, Ohio. Previous to this treatment, about once a year we took the heaters down and cleaned them out with steam. It was a week's job with two men for each unit. The thought we had when we first tried this treatment was to circulate the solvent with a pump through the heater for a period of eight to ten hours, then leave the treatment in the heater all night, recirculating again about two hours in the morning to remove remaining sludge and carbon deposits.

At our No. 2 open hearth, where we have four furnaces burning approximately 30,000 gallons of oil per day, there are two heaters for each two furnaces. We removed the heads from the heaters not in use and cleaned the heaters in service. In the No. 2 open hearth storage tank we added the chemical at the rate of one quart per thousand gallons of oil. This continuous treatment was maintained over a period of sixty days.

We then took the heads off the heaters that had been cleaned and found them to be in first class shape. The heaters that had not been cleaned were showing evidence of a cleansing action due to this continuous passage of treated oil. A later inspection of these same heaters two months later gave us a clean heater practically down to the metal.

Regarding the dumping of the gas, I don't know whether you understand our fuel burning system or not. On our mixed gas supply line we have no gas holders. We have endeavored to educate our men, as probably sixty per cent of our men have only been accustomed

to oil; they had never used gas before. We tried burning thirty, forty or fifty thousand cu ft per hour per furnace, but this did not work out. In other words our gas pressure was all over the map, ranging from 120 inches water down to 30 inches. This was the reason we decided on the dumping control as described in the paper.

Up until the time we got six furnaces on, maintaining a pressure of say sixty inches of water, we tried to hold this balance together with other gas consumers throughout the plant. There are on an average only four of these furnaces off during a period of time for tapping, making bottom, etc. We do maintain fairly good pressure by opening up the valve a small amount at first, when fifteen or twenty thousand cu ft of gas is obtained. As the pressure increases over 60 or 62 inches of water, the valve ports are controlled automatically. As far as trying to unload gas on two or three furnaces, we have never tried it.

J. F. Wilbur: With the chemical treatment, what happens to the sludge? What does it do?

F. C. Frye: I believe that precipitation takes place and, due to pre-treatment of the oil, the precipitation is kept in suspension, and the carbon is broken up and passes through the burners. My first thought when we started to use the treatment was that we would plug up our pre-heating equipment, but I wasn't worried about the open hearth because the burner nozzles are big enough to take care of it. I was worried about the strip mill furnaces, and other furnaces throughout the mill. We didn't run into any of those conditions. In other words, the carbon and sludge are broken up and carried in suspension through the burners.

It is the labor conditions and maintenance of equipment that are the vital factors today in keeping equipment clean.

P. F. Kinyoun: What has been the experience on tons per hour in the open hearth furnaces since you started using this large amount of gas? Was there an increase or decrease in the production rate?

F. C. Frye: That's pretty hard to answer; there are so many things entering into it, such as scrap conditions, different kinds of steel produced, including armor plate, etc. When we were in the automobile business, we were making 220-225 ton heats in twelve and thirteen hours. At the present time, making armor plate, etc., the heats run on an average of fifteen hours, which adds to fuel consumption. But with the lighter oils, i.e. from A. P. I. gravities of 17 to 22, the heating values have been decreased from 153,000 Btu per gal down to 146,000 Btu per gal, and the tendency is toward longer heats.

C. J. Wyrough: On the fuel distribution system described the oil is circulated through the main line by a pump and the supply line to each furnace is equipped with an individual reciprocating pump which delivers the oil to the furnace. It would seem that the reciprocating pump would give a pulsating flow of oil to the furnace, and I would like to ask what is done to eliminate this condition and provide a steady flow of fuel.

F. C. Frye: The only kind of reciprocating pumps we have are in the open hearth. The other pumps are electrically driven. In open hearth practice we maintain a pressure of 250 to 275 pounds using reciprocating booster pumps. At the burners approximately 150 pounds pressure is required. Rotary type pumps are used in all reheating furnaces to supply oil for burners.

Swalheim DISCUSSION

(*Continued from page 62*)

the strip and the contact rolls should be plated in operation. I was going to say as long as you had only steel on the top of the strip you couldn't plate tin from the strip to the contact roll.

In a recent discussion the matter of plating the contact rolls came up, and they insisted they didn't get any deplating of the strip because they got no plating on the contact roll. As a matter of fact they did have considerable plating of the contact rolls but because the contact rolls had chromium plated surfaces the tin plating was loose and washed off by the circulated solution. In this case the only damage experienced was the deplating of the strip.

H. A. Sherer: Isn't the question of arcing on the contact rolls going to determine speed, final speed probably, on zinc coatings, on heavier coatings, and so on? If the current is going to be in proportion to the coating, you are either going to have around 3500 amp per sq ft or drop down to 100 fpm. Isn't that question of arcing on the contact rolls going to finally determine that speed?

D. A. Swalheim: It is very doubtful if the cyanide bath can be operated at current densities much above 400 amp per sq ft and the plating characteristics of the bath rather than arcing troubles will be the limiting factor.

H. A. Sherer: Aren't you going to be limited to relatively thin coatings?

D. A. Swalheim: Not necessarily because the coating weight which can be applied will be proportional to the length of plating tank as well as the current density.

Spangler PAPER

(*Continued from page 75*)

be neglected during these times without crippling our war effort. The industrial engineering department is in a good position to help the personnel department devise and set up programs to accomplish the training of new men, boys and women, as well as training programs for the newly appointed foremen.

When I was in college various practicing engineers came to give lectures to the senior engineering class about the life we would face when we were out of school. I recall particularly Willard Behan, chief engineer of the Lake Shore Division of the New York Central Railroad. I don't recall anything he said to us except this one remark: "The greatest of engineering is the engineering of men." Industrial engineers now must look upon their jobs as dealing with engineering of men as well as with methods, machines and mathematics. Good team work between industrial engineers and operating and mechanical supervisors will produce the spirit that won't be licked, all of which will be our joint contribution to getting the maximum out of machines and men to attain victory in our production fight.

Bearing Metals

IN THE STEEL INDUSTRY

. . . . modifications in compositions of bearing metals necessitated by war shortages have pointed the way to many improvements which will be carried over into peacetime . . . . the design and manufacture of bearings are just as important as their composition . . . .

by S. Epstein AND *R. C. Hess*

DEVELOPMENT AND RESEARCH ENGINEER — EXPERIMENTAL ENGINEER

BETHLEHEM STEEL COMPANY

BETHLEHEM, PENNSYLVANIA

▲ WHEN Japan captured two-thirds of the world's tin resources it was obvious that we would have to get along on less tin. In the year before the war the four largest uses of tin in the United States were tin plate 44,000 tons, solder 17,000 tons, bronze 9000 tons, and babbitt 6000 tons.

As a result of an effective tin conservation program the amount of tin used for tin plate has since been cut sharply to about 10,000 tons, and that for solder has also been greatly reduced. Bronze production increased so much during the war, much of it for bearings, that in spite of a reduction in the tin content the amount of tin used in bronze has increased to over 10,000 tons a year. Bronzes now represent our largest single use of tin. In babbitt bearing metals on the other hand, it has been possible to lower the consumption of tin to only a fraction of the prewar consumption. For example, in one steel mill, the amount of tin now being used in babbitts is only ⅛ of that used two years ago. It is a satisfaction to report that the United States and her allies have recently been able to hold the consumption of tin down to approximately the current available supply, which includes a rather large stockpile of tin, the reclaiming of tin, and the smelting of tin from available ores. Most of the tin ores have been coming from Bolivia and the Belgian Congo.

The drastic cut in the use of tin in babbitt bearing metals was brought about mainly by substituting lead-base babbitts for tin-base babbitts. The lead-base babbitts have worked out very satisfactorily in the great majority of applications. Appreciable amounts of the lead-base babbitts with silver or with arsenic added have also been used. Both of these have an even lower tin content than ordinary lead-base babbitts, and besides they have the advantage of a somewhat higher hardness at elevated temperatures than ordinary lead-base babbitts.

The bearing metal is only a part of the whole in the making of a satisfactory bearing. The performance of a bearing is determined as much by its design, by the way it is cast and maintained, and by the operating conditions, as by the composition of the bearing metal. Indeed, faulty design, casting, and lubrication probably are the most frequent causes of trouble with bearings. A properly made bearing using an ordinary grade of lead-base babbitt is likely to work better than a carelessly made bearing using the highest grade tin-base babbitt.

All this was recognized from the beginning of the tin conservation program. Although bearing trouble is apt to be one of the most serious mechanical problems around a steel mill, engineers and metallurgists have generally given it relatively little study. The present temporary tin shortage, by calling attention to the problem of bearings as a whole, should produce some good results in the way of permanent improvements in practice. Before describing the compositions and properties of bearing metals a brief review will, therefore, be given of some points in the design of bearings.

Presented before A. I. S. E. Philadelphia District Section Meeting, March 4, 1943.

DESIGN OF BEARINGS

In designing bearings one must of course have a clear idea of how they work, so that provision can be made to support the load, maintain an oil or grease film between the bearing surfaces, and keep the bearing cool. In steel mills oil lubrication is mainly used on gas driven blowers and electric generators, on steam turboblowers and steam turbines, and on babbitt lined motor bearings. Oil lubricated bearings are also used on some strip mills and rod mills, and occasionally on merchant mills. Practically all pinion bearings are lubricated with oil. Grease lubrication is used on the great majority of mill bearings, such as the roll neck bearings on blooming mills, plate mills, bar mills, and merchant mills. Grease lubrication is also used on the thousands of ball bearings on mill motors and babbitt bearings on run-out tables, and accessory equipment. However, for the sake of simplicity only oil lubrication will be referred to in discussing the general principles of lubrication.

In a properly running bearing the shaft floats on a film of oil. This film has a so-called wedge shape, being thicker where the oil is dragged in at the low pressure area between the shaft and the bearing, and thinner at the high pressure area. Friction is at a minimum so long as such an oil film is maintained. The oil performs another important function in carrying away much of the heat generated by the friction. Some of the heat is also conducted away through the shaft, but a larger proportion must be carried away through the bearing and its housing. In the usual case where the bearing is duplex, that is, composed of a lining and backing, the rate at which the heat is carried away is determined to a large extent by the bond between the two. A poor bond will result in poor heat conductivity which may lead to failure of the bearing.

Thickness of bearings — Bearings must be of metal strong enough to resist the bearing pressure without flow, and heavy enough not to undergo excessive deflection. These facts determine the length, diameter, and composition of the bearing. The following are approximate values for the maximum pressure per square inch of projected area which the various bearing metals may be designed to carry. Since it is generally assumed that higher loads may be carried with grease than with oil lubrication, grease is often used for very heavily loaded bearings. Most of the older steel mill bearings are designed for grease.

	Load, psi
Lead-base babbitt	600 — 800
Tin-base babbitt	800 — 1200
Copper-lead alloy	3000 — 4000
Bronze	5000 and over

These values are only approximate. In babbitts, for example, considerably higher maximum loads may be used with grease lubrication. The average loads are much lower, the general practice being to use average loads of about 200-300 psi or less. The load that can be carried safely depends on the speed. Lower loads must be used at high speeds. The load values tabulated above are for relatively low speeds.

Where the bearing is composed of a single metal the important question of lining thickness does not enter. The bearing must merely be strong enough and thick enough. In a duplex bearing having a hard metal backing of bronze, cast-iron, or steel, and a lining of softer babbitt, it is best to have the lining as thin as possible. In this way the soft, weak lining is supported by the strong backing. Such support greatly increases the resistance of the lining to fatigue failure, that is, to cracking under repeated stress, which appears to be one of the main causes of failure in bearings.

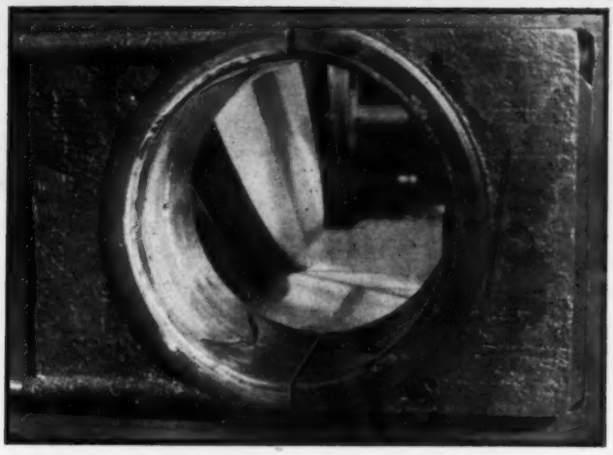


Figure 1 — Curved grooves in 20 in. diameter crank-pin bearing of power house engine.

However, to obtain this benefit from thin linings they must be made to adhere firmly to the backing so that they can be supported by it. Such adhesion is only obtained by a continuous alloy bond. When thick linings are used, bonding is not so important because the lining itself must support the load as in a bearing composed of one metal. With thinner linings, however, a good alloyed bond is essential. There appears to be no advantage in strengthening the babbitt liner by inserting bronze strips as is often done with grease lubricated bearings; in fact these strips may cause the bearing to run hot.

In considering how thick to make the lining the following should be kept in mind. On a long bearing with a large bearing surface, too thin a lining should not be used, because it becomes difficult by ordinary casting practice to fill out the mold. Linings for heavy mill bearings are generally cast with a rather generous allowance for thickness because of the large amount of wear which may occur. On the other hand, a thick lining is more apt to pull away from the backing during casting and give poor bond.

The following examples indicate suitable thicknesses for two different types of bearing linings: For a 20 in. diameter steam or gas engine bearing, the babbitt lining should be $\frac{3}{8}$ in. thick, with anchor rings an additional $\frac{3}{8}$ in. deep. For a $15\frac{1}{2}$ in. diameter rolling mill bearing the babbitt lining is generally made about $\frac{3}{4}$ in. thick. The backing must of course be big enough to remain stiff under load and not deflect or tend to close in on the shaft.

Grooving — This is a complex subject and only a few of the main points will be emphasized. Grooves are cut

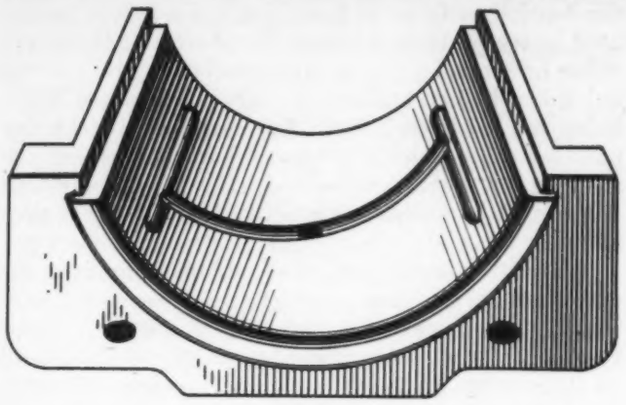


Figure 2 — Sketch showing how grooving in Figure 1 may be improved.

in bearings to provide channels in which oil can circulate and form reservoirs. The grooves are so placed that the moving member of the bearing can drag oil from the reservoir and form a wedge-shaped oil film between the bearing surfaces. Grooves should be used only if absolutely necessary — as when the bearing is so large that a continuous oil film will not be formed by merely leading oil in from the sides. Grooves must be as simple as possible. An intricate and elaborate system of grooves will cut down the bearing area and will materially lower the carrying capacity. A groove in a high pressure area will do no good but a great deal of harm. Such a groove, instead of supplying oil to the high pressure area will act as a drain into which the oil will be pushed by the high pressure. Thus the groove will drain oil away from the very area where it is most needed. Great care must therefore be taken to avoid the high pressure area and to place the groove well ahead of it. The Kingsbury type bearing illustrates the good results which follow when a wedge-shaped oil film is always caused to form by proper lubrication. The Kingsbury bearing consists of a number of pivoted pads faced with babbitt, each of which tilts and automatically adjusts itself to maintain perfect film lubrication in the bearing. Such a bearing can carry a load many times as great as an ordinary bearing not so perfectly lubricated.

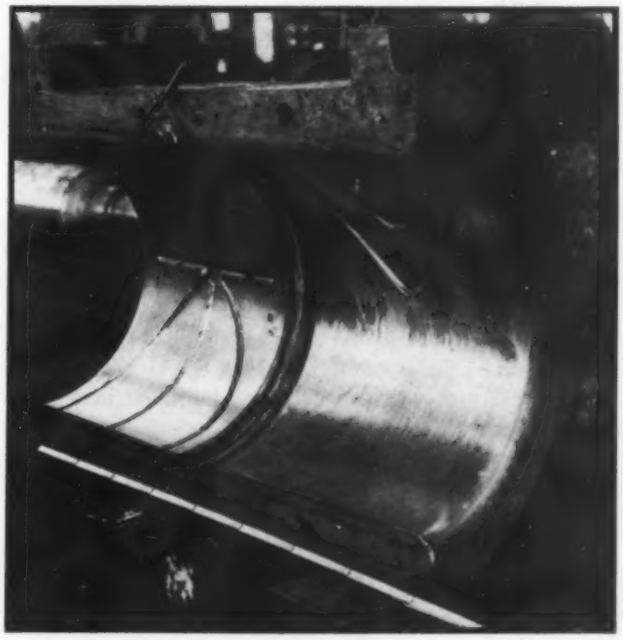
In general grooves should be axial, that is, parallel to the sides of the bearing and perpendicular to the line of motion. In this way, as a shaft rotates it drags a wide oil film in between the bearing surfaces. The simplest groove of this type, and a most effective one, is formed by chamfering or beveling the sides of the bearing. The sides should not be chamfered all the way, however, but only to within a certain distance from the ends. This is because oil led into the space between the bearing surfaces is pushed out at the ends of the bearing as well as dragged along the line of motion. To avoid excessive leakage at the ends and consequent impoverishment of oil in the middle of the bearing, grooves parallel to the sides are generally cut only to within an appropriate distance from the ends.

In high speed bearings where a large circulation of oil is desired for adequate cooling and flushing out of debris, grooves may be cut in the line of motion, that is, circumferentially, in the middle of the bearing. Such circumferential grooves may be used alone or together with axial grooves. Circumferential grooves are not nearly as effective as axial grooves in forming a wedge-shaped oil film, and they also divide the bearing area in two, but they are used where rapid circulation of the lubricating oil is desired.

Axial type grooves should be perpendicular to the direction of motion and not at an angle, for if the groove is at an angle oil will be pushed along the groove toward the ends of the bearing and away from the middle, with the result that a continuous film may not form in the middle of the bearing. This fact is often lost sight of. Figure 1 illustrates a bearing in which curved axial grooves will tend to push or pump oil away from the middle of the bearing and towards the ends. Figure 2 shows a sketch indicating how the grooving in the same bearing may be changed to avoid starving the middle of the bearing, by making the axial grooves straight instead of curved.

Measurements have been reported which indicate that improving the groove design as shown in the sketch should permit doubling the safe load on the bearing. The circumferential connecting groove between the two axial grooves should be cut at a slight angle (exaggerated in the sketch) to avoid scoring a circumferential groove in the shaft. Figure 3 shows a bearing in which the grooves are curved in the opposite direction from that in Figure 1 in order to further assure complete film formation in the middle of the bearing. In Figure 3 the bearing at the right is the bottom half, and the motion of the shaft is downward from the low to the high pressure area. The curvature of the grooves, therefore, will cause more oil to be pumped to the center of the bearing. It is questionable, however, if such recourses are often advisable. In general, straight axial type grooves are the simplest and best. Figure 3 is a pinion bearing for a 160 in. rolling mill, lined with arsenic lead-base babbitt. There is no groove connection to the thrust end at the extreme right, as side leakage

Figure 3 — Curved grooving intended to pump more oil to center of bearing.



takes care of lubrication in this particular case. This is not true of all thrust end bearings, however, and proper grooving connections should be made to them.

Under a given bearing load an oil film will be maintained over a larger arc on the circumference of the shaft when the speed is high than when the speed is low. Thus not so many grooves are needed in a high speed bearing as in a low speed bearing.

The grooves should be of sufficient cross-sectional area to supply adequate lubrication and deep enough to allow for wear and not to be stopped up by debris. They should not be cut so deep that the bearing is weakened however; about ½ the thickness of the babbitt with a circular cross-section should be deep enough. The distance from either end of the bearing at which oil grooves should finish may be calculated at roughly 1/6 of the diameter of the bore. The edges of the grooves should be rounded and filleted to prevent scraping of the shaft and wiping the lubricant from the surface of the shaft. A groove 3/16 in. in depth of circular cross-section should be bevelled at the edges so that its width, including the bevelled edges, is about 9/16 in.

Grooving is important and the responsibility for designing the grooves should be assumed by the engineer. It must not be left to the mechanic on the job. The machinist or mechanic should be supervised to see that he cuts the grooves indicated in the drawing and that he does not add his own ideas or make other changes on his own responsibility.

Clearance — Clearance is necessary to allow room for free motion between the shaft and bearing, and for the formation of an oil film. If the clearance is too small the bearing may bind. If it is too large the oil is not dragged so readily into the desired wedge-shaped film; instead, a thick film of low load-carrying capacity will result. The bearing being loose, knocking, pounding, and excessive oil leakage will occur. Within limits the effects of too much clearance can be overcome by using a higher viscosity lubricant.

A general rule is to use a clearance of .001 in. to .0015 in. for small babbitt bearings. In large babbitt bearings about .001 to .0015 times the shaft diameter in inches is allowed for clearance. With bronze and copper-lead bearings about twice the above clearance is required. A greater clearance is allowed for bronze because it does not wear in so readily as babbitt, and because it has a higher coefficient of friction; thus more space is left for the oil film as insurance against seizing. Heavily loaded rolling mill bearings require larger clearance than more lightly loaded gas engine bearings. For example, on a 20 in. diameter babbitted gas engine bearing the clearance may be .015 in., whereas on a similar sized babbitted rolling mill bearing the clearance may be .020 in.

Closer clearance can be used on precision equipment in good condition. For rougher work the clearance must be larger. Wear will increase the clearance in a short time. As a result of thermal expansion at the running temperature the clearance is reduced; such a reduction in clearance at the running temperature must be allowed for in measuring the clearance at room temperature. On bearings for rolling mill tables and drives allowance must also be made for heat transmitted from the hot steel which is being rolled.

Dirt and grit — Provision must be made, insofar as possible, to prevent dirt and grit from getting between the bearing surfaces. If the lining is hard, like bronze, hard gritty particles between the shaft and lining will either be ground down or produce deep grooves. If the lining is soft, like babbitt, the dirt is embedded in the lining and less harm is done. Even so, if a babbitt lining becomes charged with too many hard particles it will act as a lap and wear the shaft. However, if dirt and grit cannot be avoided it is better to use babbitt than bronze.

The most common method of excluding dirt is to use some form of packing, such as felt. This is not very satisfactory, however, in keeping out dirt or in preventing waste of oil by excessive leakage. Well designed oil throw rings and metal seal rings are more effective. In a lubrication system it is very important to filter the oil in order to remove the dirt after it has circulated through the bearing. It is even better to keep out dirt in the first place. However, this cannot always be done. Grease is used instead of oil in some cases because this makes it easier to keep out dirt, water, salt, and scale.

PROPERTIES OF BABBITT BEARING METALS

Although the engineer designs his bearings to maintain perfect lubrication he knows beforehand that he will not succeed. The oil film may be broken for various reasons beyond his control, for example, during starting and stopping, by excessive pressure at roughnesses on the shaft and bearing, by excessive pressure produced by deflection of the shaft, or by grit getting into the bearing. A practical bearing must therefore be made of the right bearing metal — one that will give low friction and prevent undue damage when something goes wrong with the lubrication. Experience has shown that the characteristics which might be desired in a bearing metal are actually possessed to a remarkable degree by the commonly used babbitt alloys.

Softness — It is well for a bearing metal to be softer than the shaft because most of the wear will then occur in the babbitt lining, and it is more convenient to replace the lining than the shaft. The soft bearing metals are also the ones with low coefficients of friction, and as a result they undergo suprisingly little wear in spite of their softness. In a well designed bearing the wear may be so low that the original scraper marks upon the babbitt may still show after a year's run. Lack of finish on the shaft rather than excessive load is usually the cause of wear of the lining.

The valuable characteristic of plasticity or conformability accompanies softness. Because the soft metal yields readily at high spots, the pressure cannot become high enough at such spots to rupture the oil film. A soft plastic bearing metal "wears in" readily and soon conforms to slight deflections and other irregularities in the shaft. At the same time the surface of the soft metal tends to become very smooth. These effects all contribute to the low friction shown by the soft bearing metals.

Another characteristic that accompanies softness in a bearing metal is that of embedability. With a hard bearing metal, grit may cause serious abrasion and scoring of the shaft, but with a soft bearing metal the grit can become almost completely embedded in the lining. The lining then acts as a lap and smoothes the

shaft. Of course, as the lapping action continues the clearance may become excessive.

Ease of melting — The low melting temperature of the babbitt alloys provides a valuable safety factor in bearings. When a bearing gets too hot the babbitt simply melts out. Thus, alloying of the bearing metal to the shaft does not occur, and complete seizure and irreparable injury to the shaft is averted.

Because of their low melting temperature the babbitts, when properly handled, have good casting properties and fluidity. This is important in itself and also aids in securing a good bond between backing and lining. Good bondability is a most essential requirement in a bearing metal. Poor bond is a principal cause of failure in bearings. Poor bond results in a low rate of heat transfer. As the bearing runs hotter the oil gets thinner, so that the oil film may rupture, causing seizing. The unsupported lining, further weakened by the high temperature, may crack almost immediately, or in a somewhat longer time after a network of fatigue cracks has formed.

Hardness — A certain degree of hardness and strength is also desired in babbitts. The harder babbitts will indeed wear somewhat less, but this is a relatively minor advantage. The main reason why higher hardness and strength is desired is to enable the bearing metal to support heavier loads at operating temperatures without flow or fatigue failure. It must be kept in mind that at operating temperatures the hardness of babbitts is only about half that at room temperature. Thus they are much more likely to flow under the applied load, particularly when there is excessive pounding. It is known that in general the stronger any metal is, the higher is its resistance to fatigue. This no doubt holds true of bearing metals at their operating temperatures. Therefore, the stronger the babbitt at the operating temperature, the less likely it is to fail by fatigue. Fatigue is one of the important causes of failure in babbitt linings, being brought about by high local compression stresses or by high local bending stresses.

On the other hand, the hardness must not be so high that it will unduly decrease the embedability for grit or lower the ductility to a point where the bearing metal will tend to crack in a brittle manner. The compositions of the babbitts are so chosen that they will not be too hard and brittle.

Thermal conductivity — The thermal conductivities of bronze, tin base babbitt, and lead base babbitt are to each other as 5 to 4 to 2, bronze having the highest conductivity and lead-base babbitt the lowest. The important part played by thermal conductivity in dissipating the heat generated by friction at the bearing surfaces has already been mentioned. What counts, however, is the thermal conductivity of the whole bearing assembly; that of the lining alone plays a relatively minor part, although high conductivity of the lining may sometimes help to prevent a hot spot on the lining surface. In general lead-base babbitt has a high enough thermal conductivity.

Corrosion — Ordinary lead-base babbitts containing tin and antimony are much more resistant to corrosion in normal lubricants than pure lead. Tin-base babbitt is even more corrosion resistant than lead-base babbitt and the same is true of the arsenic and silver containing babbitts. All of these babbitts have sufficient corrosion resistance at operating temperatures against the usual lubricants and against acids normally formed in engine crank cases.

Structure — The babbitt metals have a duplex structure having hard crystals embedded in a rather soft matrix or groundmass. The good bearing properties of babbitt were at one time attributed largely to this duplexity of structure. It was considered that depressions in the soft matrix form oil reservoirs which give improved lubrication, and also that the hard projecting particles support the load while the soft matrix contributes conformability and embedability. The evidence indicates, however, that the duplexity of structure of babbitt probably has only a minor influence on its bearing properties. In an actual babbitted bearing the original heterogeneous or duplex structure soon acquires a homogeneous surface anyway. As the shaft rubs over the lining the soft matrix is uniformly smeared over the whole surface, including the areas occupied by the hard crystals. Moreover, entirely homogeneous single phase metals such as pure tin and pure lead have excellent bearing properties within their limited load bearing capacities. The remarkable performance of pure silver bearings under very severe service in aircraft is proof that duplexity of structure is not essential for good bearing properties.

As with other metals, however, examination of the structure of babbitt may furnish valuable information as to conditions of casting, segregation, etc. An excessively coarse structure indicates too high a casting temperature or mold temperature. Such a coarse structure may cause brittleness. On the other hand, it is reported that an unduly fine structure, such as may be produced by too low a casting temperature and by too rapid chilling, gives low wear resistance. Such a slight improvement in wear resistance seems to be all that remains in support of the old idea that duplexity of structure (on a fairly coarse scale) is a prime requisite for a bearing metal.

TIN BASE BABBITT VS. LEAD BASE BABBITT

Both the lead and tin base babbitts possess most of the qualities discussed above to such a high degree that there is little point in making comparisons between the two types of babbitt on the basis of most of those qualities. For example, both have amply good embedability and castability. Tin base babbitt has somewhat better bondability than lead-base babbitt and better heat conductivity. Lead-base babbitt has somewhat better antifriction properties. But these differences are not very important. By and large, the main difference between the two types of babbitts is that the tin-base babbitt has somewhat higher strength at operating temperatures than lead base babbitt. As will be seen below, even in this respect, the difference is rather small.

Tin-base babbitt — Below are given compositions of two typical tin-base babbitts.

Tin	Antimony	Copper
89%	7.5%	3.5%
84%	8. %	8. %

In both of the alloys the melting point is about 465 F, only slightly higher than the melting point of pure tin, which is about 450 F. It is generally considered that the low melting point of the babbitts is the main cause of their low strength at elevated temperatures. The compositions do not contain any lead. In general lead is detrimental in tin-base babbitt because the lead tends to form, according to the amount present, a certain proportion of a tin-lead component (eutectic) having the very low melting point of about 360 F. However, up to about 3 to 5 per cent lead will do no serious harm provided the temperature at which the babbitt operates is not too high.

Antimony is added to increase the strength. It hardens the matrix or groundmass, and besides forms very hard cubical crystals of an antimony-tin compound. As is usual with such intermetallic compounds, the antimony-tin compound has a lower specific gravity than the average of the metals of which it is composed. During cooling after casting, the compound solidifies out of the molten mass as rather large cubic crystals. The low specific gravity, equi-axed shape, and large size all tend to make the compound segregate, rising toward the top of the casting. In this range of compositions, an increase in the antimony content increases the strength, but only up to about 8 per cent antimony; beyond that there is no further increase in strength. Thus, an addition of more than about 8 per cent antimony would merely increase segregation and brittleness, without any further gain in strength.

Copper increases the strength in about the same manner as antimony does. However, beyond about 4 per cent copper there is no further increase in strength at elevated temperatures. Copper also forms a compound with tin. The crystal of this compound is elongated or star shaped, and on cooling the alloy from the molten state, the copper-tin compound separates from the melt at a higher temperature than, and hence before, the antimony-tin compound. Because of this, and due to its elongated shape, it tends to entangle the antimony-tin compound, so to speak, and thus tends to keep down segregation. About 4 per cent copper is ample for this purpose. There is no advantage in adding more, since this does not confer additional strength at elevated temperatures. In fact there is a disadvantage, because copper tends to lower the fluidity, and this may injure the castability, particularly of thin bearings.

Since it is necessary in the foundry to standardize on as few compositions as possible, it would seem advisable to choose only the one tin-base babbitt shown below.

Tin	Antimony	Copper
89%	7.5%	3.5%

Lead-base babbitt — The composition of a typical lead-base babbitt is shown below.

Lead	Antimony	Tin
80%	15%	5%

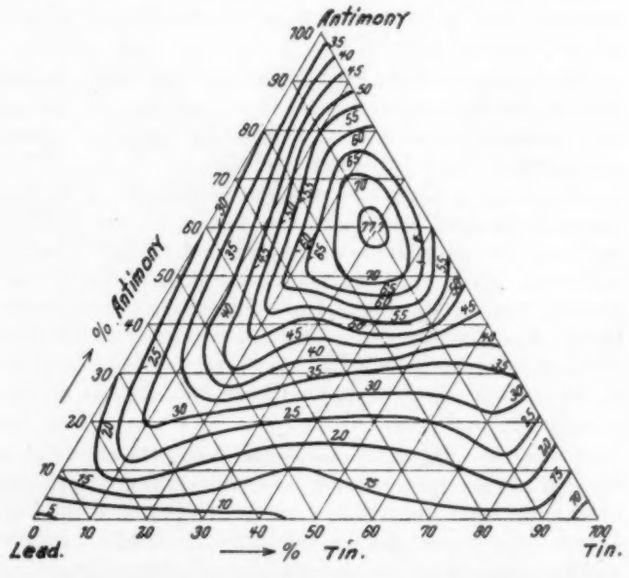
The tin content is only about 1/18 of that in the tin-base babbitt. The melting point of this lead-base babbitt is 459 F, only slightly lower than that of the tin-base babbitt.

In the lead-base babbitts also, antimony increases the hardness. Much over 15 per cent makes the alloy too hard and brittle. In the presence of tin, hard cubic crystals of the antimony-tin compound are formed which tend to segregate. Enough copper (about 2 per cent) to diminish segregation is usually not added, however, because in these alloys it tends to cause frothing during casting, and hence poor castability. About 0.5 per cent copper, may be added without harm, and this is sometimes done, as it is considered to improve the fluidity. Segregation is taken care of mainly by controlling the casting conditions so that the cast metals cool fairly rapidly.

Antimony tends to decrease somewhat the contraction which occurs upon solidification. However, the notion that it entirely eliminates contraction and even causes an expansion is wrong. Pure antimony is an exceptional metal in that it expands about 1 per cent upon solidifying. But lead-base babbitt with about 15 per cent antimony does not expand; it contracts about 2 per cent. This contraction is somewhat less than that of pure tin, which contracts about 3 per cent, and that of pure lead, which contracts about 3.5 per cent.

It was once thought that the composition with about 12.5 per cent antimony, which has the lowest melting point in this series of alloys (the eutectic composition) gives the least contraction. This is not so. The contraction is not influenced by the fact that the alloy is of the composition with the lowest melting point. For good casting properties it is desirable that the solidification range, that is, the range of temperature between the start and finish of solidification, should not be too wide. Ordinary lead-base babbitt is satisfactory in this respect, and there appears to be no point in holding the antimony content to exactly 12.5 per cent in order to obtain a very narrow solidification range.

Figure 4 — Contour lines indicating Brinell hardnesses of the lead-antimony-tin alloys at room temperature.



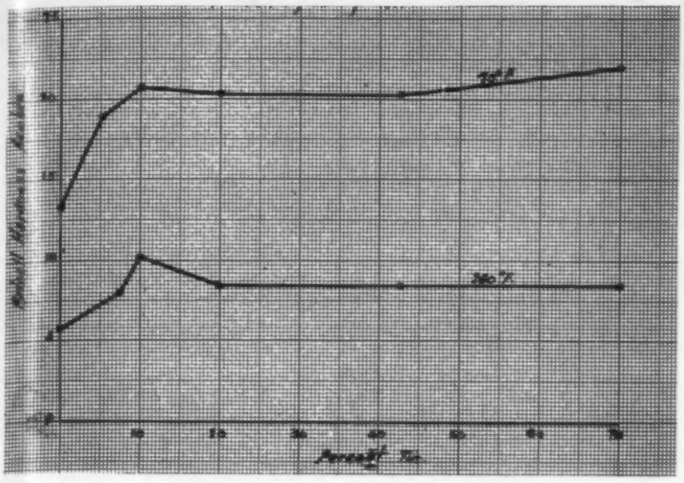


Figure 5 — Effect of increasing tin content on the Brinell hardness at 70 F and 260 F.

Addition of tin tends to increase the hardness up to about 10 per cent tin, after which there is no further increase. This is indicated in Figures 4 and 5. Figure 4 shows a diagram representing the compositions of all lead, antimony, and tin alloys. The contour lines connect the compositions having the same Brinell hardness at room temperature. Taking alloys with a constant antimony content of 15 per cent, on a line parallel to the base of the triangle, the tin increases as shown on going from the left to the right. It will be observed that the contour lines indicate that tin, up to 10 per cent increases the hardness; beyond that there is actually a slight decrease in hardness.

Figure 5 shows the Brinell hardnesses determined at room temperature, and with the specimens held at 260 F, of a series of lead, antimony, and tin alloys with constant antimony content of 15 per cent and with increasing tin contents. Both at room temperature and at 260 F the hardness goes up to a maximum at about 10 per cent tin, after which there is no further increase.

Thus, so far as strength at elevated temperatures is concerned, there is nothing to be gained by using more than about 10 per cent tin in these alloys. This amount, or even less, is sufficient to give good bondability. Indeed, if much more tin is used, so that the tin content becomes higher than the antimony content, the possibility arises of the formation of a small amount of the lead-tin component (eutectic) which melts at the very low temperature of 360 F. The presence of this low melting component is harmful, particularly at high operating temperatures.

The above point is stressed here because it is sometimes thought that raising the tin content of lead-base babbitt will make it more nearly like tin-base babbitt. Such an idea is erroneous. The tin-base alloys with high tin and practically no lead, and the lead-base alloys with high lead and comparatively low tin, all make excellent alloys. On the other hand, intermediate compositions containing both high lead and high tin, up to say 20 per cent or more tin, are definitely inferior and should not be used. Thus the WPB order which sets a maximum limit of 12 per cent tin in lead-base babbitt prevents the making of inferior bearings as well as the waste of tin.

Figure 6 shows the change in Brinell hardness of a tin-base and lead-base babbitt of the compositions indicated as the temperature is raised. In both babbitts the hardness falls rapidly with increasing temperature. At 250 F the hardness is only about half that at room temperature. The tin-base babbitt has somewhat higher hardness, but the difference between the two is not very great. When it is considered that this probably represents the most significant of the differences between the tin and lead-base babbitts, it becomes clear why bearings made of either type of alloy are so nearly equal in performance.

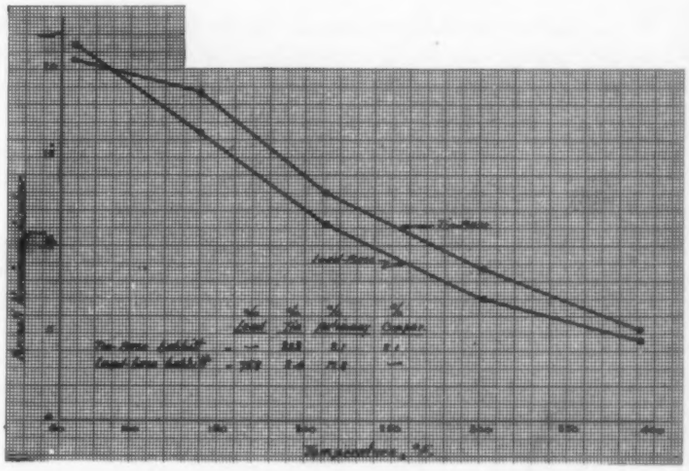


Figure 6 — Brinell hardness at different temperatures of a tin base and a lead base babbitt.

LEAD-BASE BABBITTS WITH ARSENIC OR SILVER

The main object in adding arsenic or silver to the lead-base alloys is to raise the strength at elevated temperatures. This can be accomplished with a relatively small arsenic content, as in the following typical analysis:

Lead	Antimony	Tin	Arsenic
83.75%	12.5%	0.75%	3.0%

The arsenic tends to lower the ductility somewhat, especially in the presence of tin, that being the reason for the very low tin content of only 0.75 per cent. The low tin content in turn, and also the arsenic, tend to lower the bondability. With proper care in tinning and casting, however, bearings giving excellent performance can be obtained. When using good melting practice the arsenic does not volatilize excessively during melting, so that scrap of this babbitt can be remelted and used over again, like ordinary babbitt. Care must be exercised, however, not to mix other scrap high in tin with the arsenic babbitt scrap, as the arsenic alloy becomes brittle if the tin is much over 2 per cent. The necessity

TABLE I — Brinell Hardness Tests

Type of babbitt	Composition, per cent					Brinell hardness	
	Tin	Antimony	Copper	Lead		At room temperature	At 212 F
Tin-base	89	7.5	3.5	....		18.2	10.0
	84	10	6	....		19.1	10.6
Lead-base	5	15	....	80		15.1	8.4
Lead-base with arsenic	0.75	12.5	....	83.75	Arsenic 3	16.5	10.8
Lead-base with silver	3	10	0.2	84.2	Silver 2.6	14.7	10.5

of preventing contamination by tin is a drawback of the arsenic alloys. In another alloy of this type the arsenic content is lowered to only 1 per cent:

Lead	Antimony	Tin	Copper	Arsenic
82.5%	15%	1%	0.5%	1%

Even with this lower arsenic content the tin must be limited to 1 per cent to avoid brittleness. As a result the bondability is still rather low.

Silver also increases the strength at elevated temperatures. At the same time there is no reduction in ductility. Unlike arsenic, silver has a beneficial effect on the bondability. The silver alloy is stable, and can be remelted as many times as desired without changing its composition. It is not sensitive to contamination by tin. A typical analysis is shown below:

Lead	Antimony	Tin	Copper	Silver
84.2%	10%	3%	0.2%	2.6%

To conserve the tin the content is kept low, but the amount used, together with the silver, is enough to give good bondability. The copper is added to improve the fluidity. Excellent bearing performance has been obtained with this alloy.

Table I shows the results of hardness measurements, at room temperature and at 212 F, which were made of typical babbitt compositions such as those described. The samples were cast from 800 F as 1 in. diameter bars, the molds being heated to 300 F. The as-cast samples were heated or aged 24 hours at 300 F before testing. In making the Brinell tests the load was maintained 60 seconds.

The lead-base babbitt showed somewhat lower hardness at 212 F than either the tin-base babbitt or the babbitts containing arsenic or silver. At room temperature the tin-base babbitts showed the highest hardnesses. This appeared to be mainly because the tin-base babbitt showed little falling off in hardness at room temperature as a result of the 24 hour aging treatment at 300 F, whereas this treatment appreciably lowered the hardness at room temperature of the other babbitts. Such low hardness at room temperature favors good embedability. The 24 hour aging treatment at 300 F did not, however, lower the elevated temperature hardness of the arsenic or silver babbitts, which was fully as high as that of the tin-base babbitts.

Figure 7 shows the microstructures of a tin-base, a lead-base, an arsenic, and a silver babbitt. The tin-base babbitt contains the cubical antimony, tin crystals and the elongated and star shaped copper-tin crystals which have been mentioned. The lead-base babbitt also shows the cubic antimony-tin crystals. Because of the low tin content these cubic antimony-tin crystals do not appear in either the arsenic or silver babbitts. For this reason and because of the rather fine structure, the latter are not subject to appreciable segregation.

EXPERIENCE WITH LOW-TIN BABBITTS

Experience at a typical steel plant may be cited. Before the war the main use of lead-base babbitts was on roll neck bearings — for example, in blooming and billet mills, bar mills, and structural mills. Other bearings — such as pinion bearings, bearings for all sorts of electric motors, bearings for steam engines (such as flywheel, crank-pin, and cross-head bearings), bearings for generators, compressors, and pumps, hot and cold strip mill bearings — were made of tin-base babbitts.

With the inauguration of the tin conservation program ordinary lead-base babbitt was substituted for tin-base in many of the bearings listed above (pinion bearings for rolling mills, for example) with perfectly satisfactory results. A considerable amount of lead-base babbitt with arsenic or silver added was also used.

At present the principal application of tin-base babbitt is for the main bearings and the crank-pin and wrist-pin bearings on high speed gas engines for blast furnace blowers, for strip mill bearings and for bearings for high speed pumps. These bearings are subjected to severe pounding besides being run at high speed. Tin-base babbitt is also being used on bearings for the engines which supply power to the plant, this largely on account of the severe service and because it is vitally necessary that no interruptions occur. The lead-base babbitts with arsenic or silver added may still be found satisfactory for such purposes, but the tests made so far indicate that tin-base babbitt is better.

In a particularly severe application on crank-pin bearings for steam engines on 40 in. blooming mills, the life of a silver-containing bearing, while fairly satisfactory, appeared to be shorter than that of tin-base babbitt. Tin-base babbitt is now being used in these

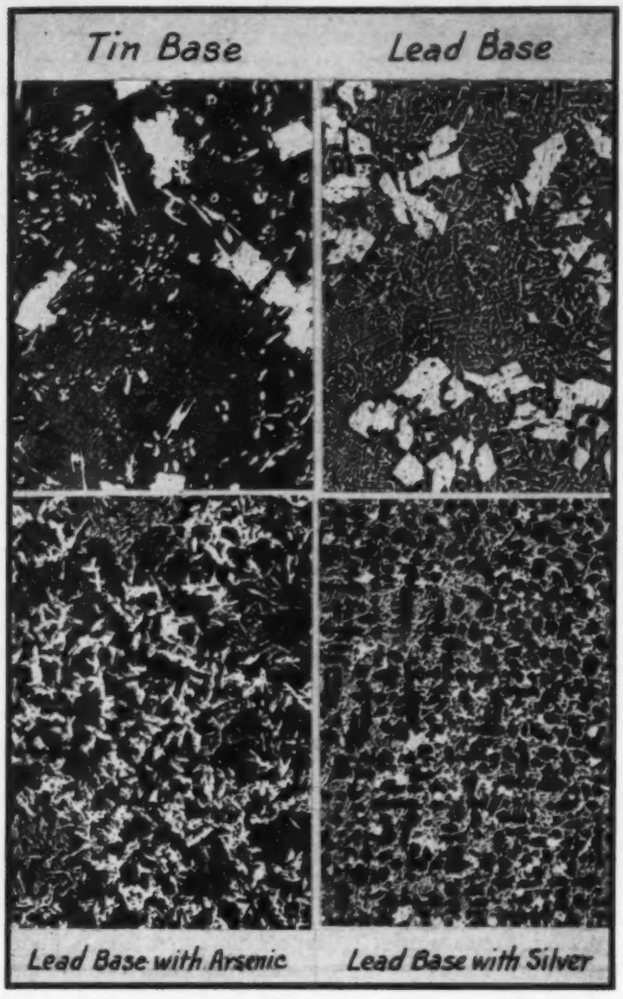


Figure 7 — Microstructures of babbitts. The arsenic and silver babbitts have a finer structure and because of the low tin content there are no cubic antimony-tin crystals.

bearings, although further tests with substitute bearings are being conducted.

The tin-base babbitts are less sensitive to the bonding procedure used than the lead-base babbitts or the arsenic or silver babbitts. This is probably the reason why the latter types have not proved fully satisfactory in the more severe applications. The tin-base babbitts have given good service without tinning the backings before casting. With the arsenic and silver babbitts on the other hand, it appears to be necessary to tin the backings well before casting. Facilities for cleaning and tinning the large backings were not available, so that hand tinning had to be resorted to for the substitute babbitts.

Figure 8 illustrates an instance where the hand tinning operation was poorly done, giving an incomplete bond. This is a 22 in. diameter crank-pin bearing from a powerhouse engine. The backing was hand tinned with a 30 tin-70 lead solder, after which the silver lead-base babbitt lining was cast. The bearing failed, as indicated in the photograph, after running only about a week. The lining evidently soon became loose and broke in a brittle manner. Here there is no mistaking the fact that poor bond caused the cracking. In some instances, however, it is hard to tell whether cracking resulted from weakness in the lining due to poor bond or merely from fatigue at locally overstressed areas.

In several instances when arsenic babbitts were used brittleness and rapid failure of the bearings were found to be caused by contamination with tin-base babbitt. Analyses indicated the tin content in the contaminated bearings to have ranged from about 3 to 8 per cent tin, which was apparently enough to make the babbitt very brittle. Precautions must be taken to avoid contamination of arsenic babbitts with tin. The silver babbitts on the other hand are not sensitive to contamination by tin.

Table II indicates the extent to which tin has been conserved in babbitt metals since the war, at one steel plant.

More babbitt was used in 1941 than in the corresponding period of 1943 because more bearings were stocked in 1941. Before the war somewhat more tin-base babbitt was used at this plant, than lead-base babbitt. Now about 6 per cent of the babbitt used is tin-base babbitt. The amount of tin-base babbitt now being used is only 5 per cent of that before the war. Present consumption of tin for babbitts of all kinds is only $\frac{1}{8}$ of the pre-war figure.

More and more of the arsenic- and silver-containing babbitts are being used, mainly in replacing lead-base babbitts. This is being done not only because they have worked out well, but chiefly because they contain even less tin than the ordinary lead-base babbitts.

EXPERIENCE WITH BRONZES

Space allows us to deal only very briefly with the subject of bronzes. Before the war the three main compositions of bearing bronzes were:

Figure 8 — Lead-base silver-containing bearing which broke loose and cracked after a short run because of poor bond.

	Copper	Tin	Lead	Zinc
(1)	90%	10%	....	....
(2)	80%	10%	10%	....
(3)	85%	5%	5%	5%

The present substitutes for these bronzes are as follows, nickel replacing some of the tin:

	Copper	Tin	Nickel	Lead	Zinc
(1)	88%	5.5%	2.5%	....	4%
(2)	76%	6. %	1. %	16%	1%
(3)	85%	3.5%	1.5%	5%	5%

For very heavily loaded bearings aluminum bronze has given very good service, better even than the 90 copper, 10 tin analysis. Only a small quantity of this has been used, however. Silicon bronze also gives very good service but since it requires the use of virgin copper it has not been used to any appreciable extent.

Figure 9 illustrates one of the few instances where the 88 copper, 5½ tin, 2½ nickel, 4 zinc composition did not appear to make a fully satisfactory substitute for the 90 copper, 10 tin alloy formerly used. The antifriction properties seemed to be insufficient so that the roll-carrier cast from the substitute alloy scored the roll-neck of a 10 in. bar mill. The diameter of the roll-neck is 7 in. Good service is now being obtained by casting the roll carrier of an 85 copper, 3½ tin, 1½ nickel, 5 zinc, 5 lead alloy. This alloy, containing 5 per cent lead, appears to have satisfactory antifriction properties in this application.

It has not been possible to save as large a proportion of the tin in the bearing bronzes as in the babbitts. Nevertheless, at present the tin content of the bronzes used for bearings is only about half of what it was before the war.

CASTING BABBITT

Good casting practice must be observed to get good bearings. It is advisable that the casting be done at a central babbitting station under the supervision of someone with a knowledge of babbitt metals and with experience in good foundry practice. Facilities must be provided for controlling the babbitt compositions and casting temperatures, and for properly cleaning and tinning the backings. It does no good to recommend good practice if the facilities are not provided. Passable results can be obtained without tinning the backings, but if proper facilities are made available a good tinning job can be readily done. Improved results would soon pay for new equipment.

Melting out old bearings — To avoid forming too much dross the flame should not impinge directly on the babbitt. Excessive burning out temperatures will also cause excessive drossing. A good way to melt out the babbitt is by immersing the bearing in a pot of molten babbitt.

There should be no hesitancy about using remelted babbitt so long as the composition is closely controlled by chemical analysis. Remelted babbitt of the right composition should be better than virgin babbitt of the wrong composition. Whether or not a babbitt is suitable should be determined by chemical analysis, and by mechanical and other rational tests, and not by somebody's feeling that it is getting old or by the assumption that if it is virgin metal it must be all right.

Cleaning and tinning — Tinning of the backing is essential to insure a complete metallic bond between the backing and lining, although it is not as yet common practice to tin all backings. If one could be sure of perfect tinning anchor grooves could be eliminated in many cases. A tin-base babbitt is more likely to give a good bond than a lead-base babbitt, but even with a tin-base babbitt the backing must be thoroughly cleaned and tinned to insure a complete bond. On the other hand, after proper cleaning and tinning there is no difficulty in getting a complete bond with lead-base babbitt or with the arsenic and silver babbitts.

The backing should be thoroughly cleaned and degreased, for example, by sand blasting if this is necessary, and by boiling in a hot 30 per cent caustic soda solution before tinning. It may be advisable to degrease the bearing before the old babbitt is melted out. Oil trapped between the lining and backing may become charred during burning out the babbitt lining and therefore more difficult to remove. The surface should be fluxed before tinning. Zinc chloride with about 10 per cent hydrochloric acid and about 5 per cent ammonium chloride is a good flux. A cleaned steel surface will tin as easily as a bronze surface. Special precautions must be used to clean cast iron in order to remove graphite from the surface. The graphite may be burned off by immersing in a molten bath of oxidizing salts, such as a mixture of chlorate and nitrate salts. A wiping solder of 70 per cent lead and 30 per cent tin may be used for tinning. The tinned layer should be thin, but

TABLE II

	Total weight of babbitt metal used, lb		Weight of tin in babbitt metal used, lb	
	July to December, 1941	July to December, 1943	July to December, 1941	July to December, 1943
Tin-base babbitt	61,200	3,180	52,900	2,860
Lead-base babbitt	52,600	57,000	2,600	2,850
Lead-base with arsenic	.....	19,000	.....	140
Lead-base with silver	.....	18,600	.....	550
Total	113,800	97,780	55,500	6,400

continuous. The quality of the tinning may be checked by tilting the backing while it is still hot, so that the solder flows over the face. If the flow is smooth and unbroken good tinning has been obtained. The use of a tinning bath large enough so that the cleaned backing can be dipped into it will enable a good tinning job to be done quickly and conveniently. It is desirable to pour the babbitt while the tinned layer is still molten.

Melting and pouring — Care should be taken not to overheat the molten metal, and it should be well stirred. Accurately calibrated pyrometers should be used to control the temperatures. In making additions to a babbitt bath it is not necessary to heat the whole bath to the temperature of the high melting point metal being added, say antimony. The added antimony will dissolve readily in the bath at temperatures well below its melting point. The most convenient way of mixing babbitts, however, is to melt separately a hardener mix containing the high melting constituents, and then to add this molten hardener mix to the lower melting constituents. Thus, for tin-base babbitt, the hardener is mixed by melting the copper first, and adding the antimony and a small amount of tin. This molten hardener is then added to the molten tin. Again, for lead-base babbitt, the hardener is mixed by melting the antimony with some lead added. The molten hardener is then added to the melted lead and tin. The temperature of the molten babbitt should not be allowed to exceed 1000 F and it should only be held at this high temperature for as short a time as possible. The use of ammonium chloride as a flux in the babbitt pot will reduce the amount of dross. Powdered charcoal may also be used for this purpose.

In pouring, use of the lowest temperature which will give a sound casting will result in a better structure and tend to avoid segregation. The proper temperature in any instance will depend on the size and shape of the lining and the condition of cooling. A thin lining on a large backing, which will be cooled rapidly, will require a higher pouring temperature to insure a sound casting than will a thick lining. The pouring temperature of lead-base babbitts may be somewhat lower than that of tin-base babbitts, because the lead-base babbitts are completely liquid at considerably lower temperatures. The tin-base babbitts, because of the high temperatures of complete liquefaction, are less fluid and a higher pouring temperature must be used. A good working range for bearings of average dimensions is 800-950 F for tin-base babbitt, and 750-900 F for lead-base babbitt.

Figure 10 shows a backing and mandrel assembled for casting the lining of a roll-neck bearing for an 18 in. billet mill. The backing is toward the front and the mandrel is at the back. Before pouring, the backing should be heated to about 250-350 F and the mandrel about 100 degrees hotter. Temperature indicating pencils are very convenient for measuring the temperature of the backing and mandrel. If the babbitt is poured against a cold shell it may become chilled and give poor bond. The mandrel is heated to a higher temperature than the backing so that solidification starts from the surface of the backing and not from the mandrel. Shrinkage will then be toward the backing and not away from it, so that there will be no tendency to rupture the bond between the backing and lining. Cooling

Figure 9 — Roll neck scored by bronze roll-carrier.

Figure 10 — Assembly for casting lining of a roll neck bearing for an 18 in. billet mill.

the backing by compressed air, or by a water spray will also aid in this respect.

In pouring, it is well that the ladle should be large enough to fill the whole mold in one pour. It will then not be necessary to stop the pour while getting another ladle full of metal. Delays cause cold shuts and separations into layers in the lining being cast. The bottom of the casting assembly should be well stopped to avoid leakage, as the metal already poured will become chilled during the time required to stop the leak. Rabbling or stirring the molten metal in the bearing is sometimes helpful in avoiding cold shuts and local shrinkage.

Machining — It is desirable to machine the bearing surface and not merely to depend on the wearing in of the surface cast against the mandrel. This may not be uniformly smooth and may contain injurious dross or cavities. Machined bearings will give better results even when it is possible to get along without machining. Better performance will more than pay for the machining in the long run. Light finishing cuts should be used to get as smooth a surface as possible.

DISCUSSION

PRESENTED BY

C. R. HAND, Lubricating Engineer, Bethlehem Steel Company, Sparrows Point, Maryland

FORD CORDIAL, Kolene Corporation, Newtown, Connecticut

W. C. SCHULZ, Superintendent Power and Maintenance, Bethlehem Steel Company, Steelton, Pennsylvania

S. EPSTEIN, Engineer, Development and Research Department, Bethlehem Steel Company, Bethlehem, Pennsylvania

T. S. SITTERLEY, The Cleveland Graphite Bronze Company, New York, New York

R. C. HESS, Experimental Engineer, Bethlehem Steel Company, Bethlehem, Pennsylvania

C. C. ADAMS, General Foundry Foreman, Bethlehem Steel Company, Sparrows Point, Maryland

J. C. REED, Superintendent Electrical Department, Bethlehem Steel Company, Steelton, Pennsylvania

J. T. REA, Superintendent of Maintenance, Manufacturing Division, Bethlehem Steel Company, Bethlehem, Pennsylvania

L. F. COFFIN, Superintendent Mechanical Department, Bethlehem Steel Company, Sparrows Point, Maryland

C. R. Hand: The authors have given us an excellent paper that should be of benefit to all concerned with babbitt or bronze bearings. Attempts have been made to obtain satisfactory bearing metals; metal combinations for these purposes are very numerous and each combination has been developed to serve some particular set of conditions. A study of various mixtures soon indicated the folly of so many slight variations in analysis. Pick up any handbook and you will find a whole page of them.

The problem of proper bonding is still far from solved. Numerous failures of high-speed engines today are due entirely to failure of the bonds. We have diesel engines at Sparrows Point and many bearing failures have been nothing else but the babbitt or the bearing metal letting go from its bond on the bearing shell, becoming wedged between the crank-pin or wrist-pin, and scoring and ruining the bearing.

Similar failures occur in the steel mill for the same reason. Attempts have been made to reduce the bearing metal in the shell from one-quarter to one-half the former thickness. We are about to put a bearing in a gas engine where we have cut the babbitt thickness from three-quarters to three-eighths.

Bonding strip metal to brass or steel chucks is almost impossible due to thermal changes. Figure 8, which showed the babbitt cracked out of the shell, looked rather familiar. I don't think it came from Sparrows Point, but we have lots of failures like that, both with tin babbitt and others, and a few with arsenic babbitt, the cause in all cases being due to the fact that up to the present time we do not know how to properly tin a bearing of that type. We are still trying. Each bearing must be studied and the proper thickness can be arrived at only after trials. I think that is fundamental. I don't know of any formula for determining what that thickness should be for a given diameter or length. Many large engine bearings — and I think this can be proven — can be reduced to at least half of their present thickness of babbitt. That will also be true on many of our large pinion bearings.

Grooving is another feature of a bearing that should be given considerable attention. We have tried to give the bearings at Sparrows Point some attention and have succeeded in eliminating some of the troubles formerly experienced by leading additional oil lines into a bearing and changing the set of grooves to lead the oil to positions where we expect it will do the most good.

I certainly agree with Mr. Epstein that the problem should not be turned over to the machinist in a shop with a pneumatic hammer and gouge, and tell him to put a set of grooves there.

There has been much work done on the distribution of oil to the proper pressure areas. The oil lubricated roll-necked bearings now in service in many mills are an excellent example of the proper application of oil to the pressure areas. The speeds on some of these mills and the extreme loads can only be carried when oil is properly distributed.

Clearance is another problem of a bearing that requires study for each application. The general assumption of a thousandth and a half per inch over six inches does not apply to all bearings.

Dirt and grit should be of particular concern to all who are responsible for bearings. Much work has been done to improve bearing design to keep out foreign matter. There are many different types of devices on the market that can be applied to the older bearings. Many of these do a good job. Here again each application must be studied. The manufacturers of these sealing devices try to emphasize that speed is the element that they are particularly concerned with so that they can design or develop materials that will have suitable coefficients of friction to accommodate the speed without damage to the seal.

There are many types of oil filters on the market. We have several different types at Sparrows Point. These all do a fair job of filtering the oils used in circulation systems. Some do a more complete job than others. But here again the degree of perfection desired has to be arrived at after careful study and purchase of the proper type of filter.

Shaft finish has much to do with long bearing life. However, super-finish seldom contributes much to long bearing life; due to chemical action and abrasive material entering the bearing, much of the work done to obtain this finish is quickly nullified.

Some of our mill pinions at Sparrows Point originally using tin-base babbitt have been equipped with the arsenic-lead type, or "G" babbitt, as it is known, and we have had fair success. We have one set in our 160 in.

mill that was originally put in in August 1942 and came out in March 1943 because of worn teeth on the pinions, and was put back again in June 1943 and is still in.

Ford Cordial: In connection with bonding, our company emphasizes the importance of cleaning the base metal or bearing back. We accomplish our cleaning by a process we have developed which enables us to get a chemically clean surface on steel and even cast iron which can then effectively be tinned; and we can take a grey iron casting and clean it with a high lead alloy containing very little tin. It has been proven that when a bearing metal is cast upon this "tinned" surface, the bond resulting is so strong that in most instances it has been possible to eliminate grooves and dovetails thus saving many hours of expensive machining. Of course, being able to eliminate the grooves and machining, we are told by bearing people, results in a better bearing because of superior heat dissipation through the bearing back, in addition to uniform backing. Furthermore, it makes it possible to apply thinner linings of babbit metal to the bearing shell thus enabling an approach to the subject which Mr. Epstein and Mr. Hand have spoken of, namely, an attempt to get better heat dissipation and reduced fatigue of bearing metals through the use of thinner babbitt lining.

It may be of interest to you that in this cleaning, and we speak usually of cast-iron because it has been recognized as one of the most difficult of the common metals to clean, not only do we remove surface dirt such as oil and grit, but also graphitic carbon which heretofore has been considered practically unremovable by any known method. Micro-photographs have shown when a bearing is tinned with a low-tin alloy the tendency is for this metal to flow into the microscopic apertures caused by the removal of graphite. In effect, we get hundreds of little fingers all over that surface to which the bonding metal is anchored, and when you cast the bearing metal on that, you get the result of extreme shear strength. Some tests I have in mind show shear strength running 9000 to 10,000 and over 12,000 psi. A characteristic result is that in attempting to break the bond of a lead base babbitt (although this method is not limited to lead), the bond holds and the babbitt fractures. Better cleaning also makes possible greater strength of brazed joints between cast iron and steel. We have an application, for example, where there was a case of failure where steel was brazed to cast iron. This brazed joint looked perfect, but under test it failed. It was found after the application of this thorough cleaning that, in attempting to break subsequent brazed joints, the joints held and the cast iron fractured.

So we emphasize, and believe that most people are coming to agree, that cleanliness in the preparation of the bearing and in babbitting of a bearing is next to godliness — too much importance cannot be put on it.

We think that centralization of babbitting operations in manufacturing, the careful training of operators in the handling and processing of bearings, careful control of temperatures and such, is vital. These steps, we have found, almost certainly lead to improvement of the bearing itself. This process, of course, is equally applicable on steel.

I might mention that the cleaning is accomplished by a powerful oxidizing bath of molten salts. It is particularly effective in cleaning the bearing that has been out in the field and preparing it for re-babbitting. We can bond, and it is possible to bond cast-iron as well as steel, and in most instances it is possible to eliminate hours of machining of grooves and dovetails and still secure the well bonded linings of which Mr. Hand and Mr. Epstein have spoken.

W. C. Schulz: We have had failures with high lead bearings containing arsenic. We have not tried any silver. I would like to know the relative amounts of arsenic and silver babbitt used.

S. Epstein: We have used about the same amounts of the two babbitts, as shown in Table II; about 19,000 lb of arsenic babbitt were used and about the same amount of silver babbitt in the last six months.

W. C. Schulz: What size bearings have been used with silver babbitt?

S. Epstein: As large as 22 inch crank-pin bearings.

W. C. Schulz: You have had better success with silver than with the arsenic?

S. Epstein: We have had good success with both but the silver is less subject to contamination. We have had good success with both of them, however.

T. S. Sitterley: As to the question of thickness of the lining material, we, in our work with babbitt and steel-backed babbitt bearings have found a great deal of success with liners reduced in thickness below that of bearings which have walls running a quarter inch and thicker babbitt.

We have set up in the engineering department a somewhat basic grouping or standard according to inside diameter dimensions of bearings and all these sizes carry the same babbitt thickness of liner, $\frac{1}{32}$ in. That seems quite a thin wall or layer of babbitt. We have had limited experience in the field of rolling mills. However, these standards used in the diesel engine field and also on turbines or marine reduction gears have proven very satisfactory.

We have been working with one company on roll neck bearings. They are using a certain type shell and we have cast in some of this high-lead babbitt, with the thickness of liner of around $\frac{3}{16}$ in. We are experimenting now to cut down this thickness to $\frac{1}{8}$ in., or possibly to a $\frac{1}{16}$ in., depending on the shaft or roller itself to maintain its true axis or whether it will bend or warp out of shape under the pressure in the mill. As I understand from Mr. Epstein's comments, apparently this liner wall is much thinner than types the steel rolling industry has used.

The reuse of babbitts is very interesting. We ourselves reclaim a great percentage of our babbitt from our finish machine operations. It, however, is most important to have very accurate analyses of the metals before reuse, to assure that your formula is correct, as mentioned by Mr. Epstein. It can be done, however; care must be taken not to contaminate your particular alloy through a mixup of scrap.

The comments on grooving were most enlightening. Apparently grooving is a subject for conjecture, but it has been found that simplicity of grooving is most important. If you get a direct flow of oil to the low-pressure area, you are introducing oil to facilitate the weding action, and oil in plentiful quantities at the point of wedging is important. The use of spreader grooves at the parting lines has proven very effective

for distributing oil longitudinally as long as the groove does not continue to the ends of the bearing. The circumferential grooving may be kept much in the order shown in Figure 2. The grooves should not be in the high pressure area, as was indicated, but at times you find one has to put them there to get larger amounts of oil directly to those points where the wedging action starts, and also to improve cooling of the journal.

Member: On those big bearings how do you bond and pour them to get the $\frac{1}{32}$ and $\frac{1}{16}$ inch lining?

T. S. Sitterley: On cast-iron bearings, we have used our special process and on steel shells we do our utmost to assure cleanliness of the shell. As to machining the shell before babbitting, there does not necessarily have to be a fine machine finish to assure a bond. We don't look with favor upon mechanical bonding features, such as circumferential anchor grooves in the steel or locking wedges. We found they are unnecessary and often detrimental, especially when you get to thin babbitt layers. If you can clean the shell well, with a good pickling or whatever method used, and be assured that surface is properly fluxed and tinned, you can get a very satisfactory bond, no matter whether the babbitt layer is ultimately $\frac{1}{32}$ in. or whether it is a $\frac{1}{2}$ in. The most important factor is your bond; without good bond you are not going to have good service life. Our shells are centrifugally cast and finished machined or diamond bored to dimension.

R. C. Hess: In general, at Bethlehem we have used silver lead babbitt in engine bearings because we feel it is a little more ductile than the arsenic lead babbitt. We have used the arsenic lead babbitt mainly in mill bearings. However, because we do not want to have too many babbitts in any one part of the plant, we use only silver babbitt in one part of the plant and arsenic babbitt in the other, even though the applications in the two parts of the plant are alike.

C. C. Adams: I was very much interested in the babbitt compositions. It is noticed that the arsenic babbitts carry a small amount of tin. It has always been my supposition that the small amount of tin that is carried in this babbitt is due to the fact that sometimes they are made up from what we might term scrap babbitt, and they pick up this little bit of tin.

Personally, I can't see where .75 per cent tin has much beneficial effect. It is a fact that our high lead babbitts will give good results if they are properly applied and properly lubricated. Of course it is useless to argue which is the better babbitt. Tin-base babbitt is a much better babbitt for certain operations.

We at Sparrows Point used as much as 90,000 lb of tin-base babbitt in the year 1941, and through the efforts of our mechanical department we reduced that amount to as low as 1800 pounds for one year. Our tin-base composition is 80 per cent tin, 15 per cent antimony and not over 5 per cent copper. We do not use old babbitt metal in its manufacture. We figure we get a good copper-tin and antimony-tin crystal for the bearing load.

J. C. Reed: I am glad to know that a good case has been made for lead-base babbitt, since I have been using it for motor bearings for thirty-five years.

Based on experience I have had, it is my conviction there is something in making babbitt besides the elements which compose it, because I have had babbitts obtained from two different sources, with the same analysis, but of which one worked all right and the other did not.

I have never used lead-base babbitt for anything except motor bearings, both the armature bearings and back shaft bearings. Our practice has been to use phosphor-bronze bearings on other parts of cranes. Such substitutes for phosphor-bronze as we have received have not always been satisfactory, and we have found it necessary to improve our machining practice in order to use them. We have found the substitutes required a smoother finish on the journals. We have also found that, where the pressures are high, they would not work at all, so we have resorted to half-soling the old bearings in order to keep going, and in this way use the bearing a second time. Since it is the bearing we are wearing, and not the half-sole, I can't keep up this practice indefinitely.

J. T. Rea: There is much of importance in this grooving of bearings, as has been brought out very well. But I think another thought should be added, and that is that the front or leading edge of the groove must be flared or beveled so as to allow the oil to get out, helped by rubbing action of the shaft.

Some may say that there are lots of grooves that have never been flared and the bearing worked all right. That is true. We are not worried at any time about the bearing that works all right; it is that marginal bearing that gives us trouble, and we keep on having trouble with it. That is the one that needs the attention. And we have found that by flaring or beveling off the front face marginal conditions can often be considerably improved. I only mentioned this because Figure 2 in the paper didn't bring it out fully, and it is very important.

One other point is that the grooves discussed in the paper are for oil. Usually you find that where grease is used the grooves must be given diagonal persuasion to feed the grease along the groove. Very frequently it is found beneficial to slope the ends of the grease grooves so that any foreign matter may readily work out. A square ended groove is often a trap for foreign matter. In a reversing bearing both sides of the groove must of course be flared or beveled.

In the bearings which have considerable circulation of oil, it is very desirable to bring the oil in from the oil hole by means of a diagonal groove, and then carry it across the bearing into collector grooves on the sides.

On the suggestion that all grooving should be laid out in the engineering department, it is a good idea, but I think we would go much farther than that and bring our knowledge to the mechanic in the field. If you don't do that, he is going to defeat your engineering work the second time the bearing is babbitted. The idea of the straight groove is very sound, as is the slanting groove for grease, but the missionary work must be done out in the field or your engineering work is going to last only for one time.

The discussion of types of bearing metals was most interesting, but as Mr. Adams brought out, after all we must lubricate the bearing. That is always the first consideration. The central lubricating system is a problem about which everyone is very much concerned. It can be carried to extremes, but it certainly is the line along which most of us are working to improve our bearing situation.

As to the question about recovery of bearing metal,

the biggest trouble in the recovery of bearing metal in the machine shop is to get them to do it right. If they collect the chips of the 89 per cent tin babbitt, in a little tray and have a separate place to put the chips, good chips will be returned for remelting. That seems simple enough; nevertheless it is extremely important. Bearing metal can be melted and remelted without any considerable difficulty in our experience, but it must be kept segregated.

In melting out babbitts a soft gentle flame is essential. The fellow who allows somebody to do a quick job with a burning torch will find that it is no good. Keep the burning torch off of it. Those points I have found in my experience are most important in the reclaiming of babbitt metal. Otherwise you can generally handle the reclaimed metal much the same as the virgin metal.

I was very much interested in the very thin babbitt metal linings and in the discussion of bonding. I think one thing we should study more than ever before is bonding. Someone may say, "Why not go to the very thin linings in all our bearings?" It is not a simple matter, for we have thousands of bearings made for thick linings and it is not readily possible to change them. But I think on the new bearings attempts should be made to go to the thinner linings.

L. F. Coffin: While thin lined bearings are the goal to strive for we must bear in mind that there are many poorly designed installations where misalignments are the rule and where operating conditions such as scale, poor lubrication, etc., require a thicker lined bearing. Many installations of the more modern type with oil lubricated bearings permit the use of thin lined bearings.

With proper bonding it seems that arsenic babbitt could be used on almost every bearing application in our plant, even in gas engine crank-pin bearings. We have a 3500 kw blast furnace gas electric engine that has a 22 inch crank-pin bearing. In this bearing a 3 per cent arsenic-lead babbitt operated for a year with practically no wear. The babbitt lining was ¾ inch thick. At the end of the year it had to be taken out of service because there was no bond. We had attempted to bond it by hand tinning. We had another bearing last for six months, with practically no wear, but it broke loose due to poor bond.

We do know, however, that babbitt can be properly bonded by a chemical cleaning and tinning process, as well as by a hydrogen torch method. We have one 10 in. diameter bearing on a high speed rod mill where the lead arsenic babbitt thickness is about $\frac{3}{32}$ in. This has been operating for several months, bonded by a chemical cleaning process on a smooth steel shell with absolutely no grooving of any kind. The life to-date is as satisfactory as the original cadmium-silver linings furnished by the mill manufacturer.

As for brass strips in the old type babbitt mill bearings, they are worse than useless. We have lead-base babbitt in the top and bottom roll bearings of a 40 in. x 80 in. slabbing mill. They are open type bearings, lubricated by a forced pressure grease system. The bearings were tinned by hand onto a steel shell. These bearings have given satisfactory service during the rolling of more than 1,500,000 tons of product. This record is more than ten times as high as was previously obtained with the same babbitt with brass strips.

While it is of course correct that cracks in babbitted bearings may come from fatigue and overloading, in steel mill practice the great majority of cracks are probably caused by poor bonding. The bearing metal situation brought about by the war has emphasized the harm done by poor bonding. In time the steel mills should profit greatly by this lesson. There is no question at all but that good bonding will make it possible to use any of the standard babbitts.

Now for a word of caution. We are experimenting with arsenic-lead and silver-lead babbitts. These in the course of time will probably replace nearly all the tin babbitt, even after the war. During this present experimental period, we should determine how we want to babbit our bearings on a production basis. What babbitt are we going to standardize on? We should make someone responsible for all the babbitting in the plant. Otherwise we are going to have some terrible problems of contamination and contamination of arsenic-lead babbitt is simply disastrous. A plan must be carefully thought out for doing this job on a plant-wide basis before you start, and not afterwards.

S. Epstein: By now we should have all gotten the point that we must have a good bond to get a good bearing. In the steel mills we are not getting a good chemical bond and are depending too much on mechanical bonding.

Also it is not enough to say "Get a good bond," unless the men who are asked to get the bond are provided with the proper facilities. I think we have been lax in not providing the men in our foundries with the proper facilities for getting a good bond. If we had the same facilities in the steel mill foundries as the automobile plants have for making their bearings, we would get equally good results.

It would be nice if some steel mill would put up a really fine central babbitting station with the proper cleaning and tinning facilities, etc. Once it is shown that the expense of such an installation can be well repaid by savings in bearing maintenance costs other mills will follow suit.

About the question of reclaimed babbitt, the point is that it is the composition of the bearing metal that counts, not how old it is. There is no such thing as virgin metal. The metal is what the analysis shows. There should be no hesitancy about using remelted babbitt so long as the composition is closely controlled by chemical analysis and the usual precautions are taken not to heat the metal too hot and to keep it clean by proper fluxing. This applies to the arsenic and silver babbitts in the same way as to the lead and tin base babbitts. The same melting procedure and casting temperature can be used on the arsenic and silver lead-base babbitts as on ordinary lead-base babbitt.

Mr. Adams doubts that the 1 per cent or less tin in the arsenic babbitt composition contributes materially to its properties. He thinks this small tin content is specified merely because some tin would get in anyway from scrap, etc. A tin content of only 1 per cent is indeed very small and would not be expected to have a very marked effect, but still it is generally held to improve the bondability somewhat. More tin would be desirable for this purpose, but in the presence of arsenic more tin would cause brittleness. So a compromise is made at 1 per cent tin. In the silver babbitt the 3 per cent tin content is believed to make a definite contribution to bondability.

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The fuse link used is the famous "BUSS Super-Lag." It has lag-plates attached to it. These give a long time-lag so that unusually heavy starting current or other harmless overloads will seldom cause the to blow.

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Pass the word along that all purchase records dealing with circuit protective devices should be immediately changed to call for BUSS Super-Lag Renewable fuses. Then, as fuses are replaced or new installations made, your plant will automatically get the benefit of the carefree, trouble-proof protection that BUSS Super-Lag fuses afford.

BUSSMANN MFG. CO. • University at Jefferson, St. Louis 7, Mo.
Division McGraw Electric Company

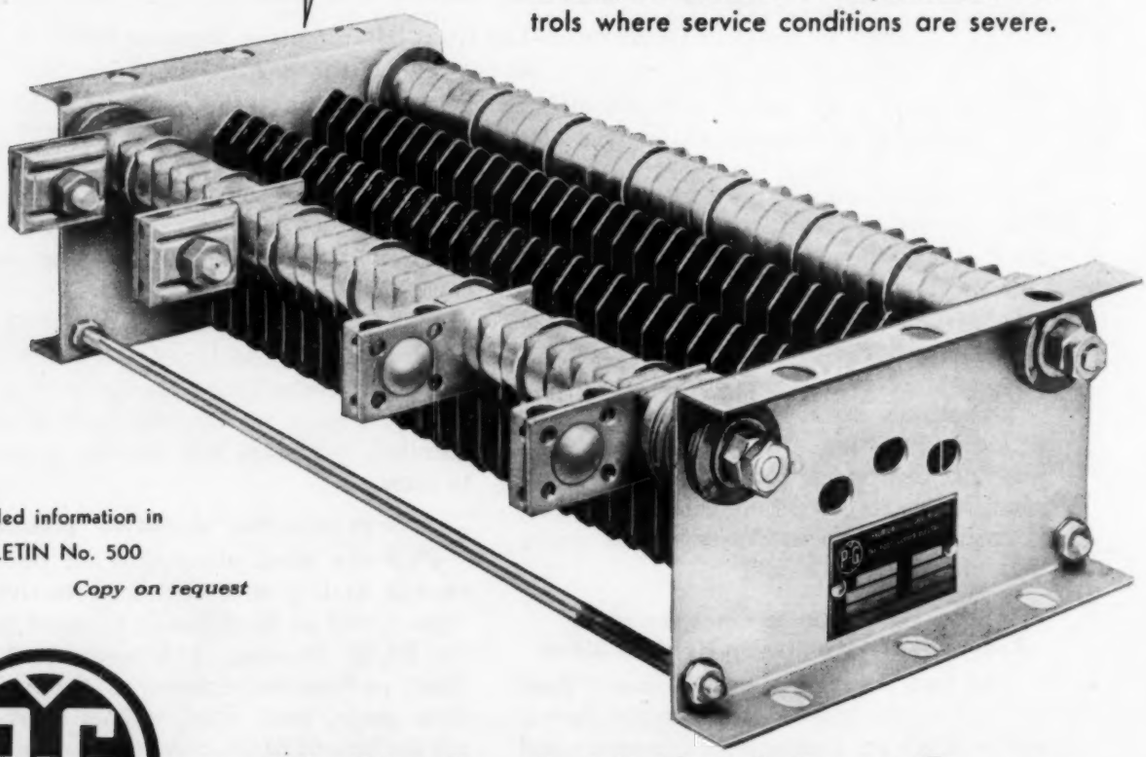
SUPER-LAG FUSES
SOLD THROUGH WHOLESALERS

- ☆ All Steel Construction
- ☆ Mica Insulation
- ☆ Rugged Terminals
- ☆ Provision for Expansion
- ☆ Adequate Ventilation
- ☆ Unaffected by Vibration
- ☆ Moisture Resistant
- ☆ Corrosion Protected

Durable

Yes... Steel and Mica added to the unique and exclusive P-G design, results in enduring resistor service. Steel mills everywhere are specifying P-G Steel Grid Resistors for tough spots where Trouble-Free service is a must.

Try P-G for heavy duty service on cranes, ore bridges, ore unloaders, charging machines, mill tables or for any other mill controls where service conditions are severe.



Detailed information in
BULLETIN No. 500
Copy on request

P-G

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY
• ESTABLISHED 1892 •
221 WEST THIRD STREET, CINCINNATI 2, OHIO

but . . . you can improve your products now

Heppenstall Forgings

will give them market winning serviceability

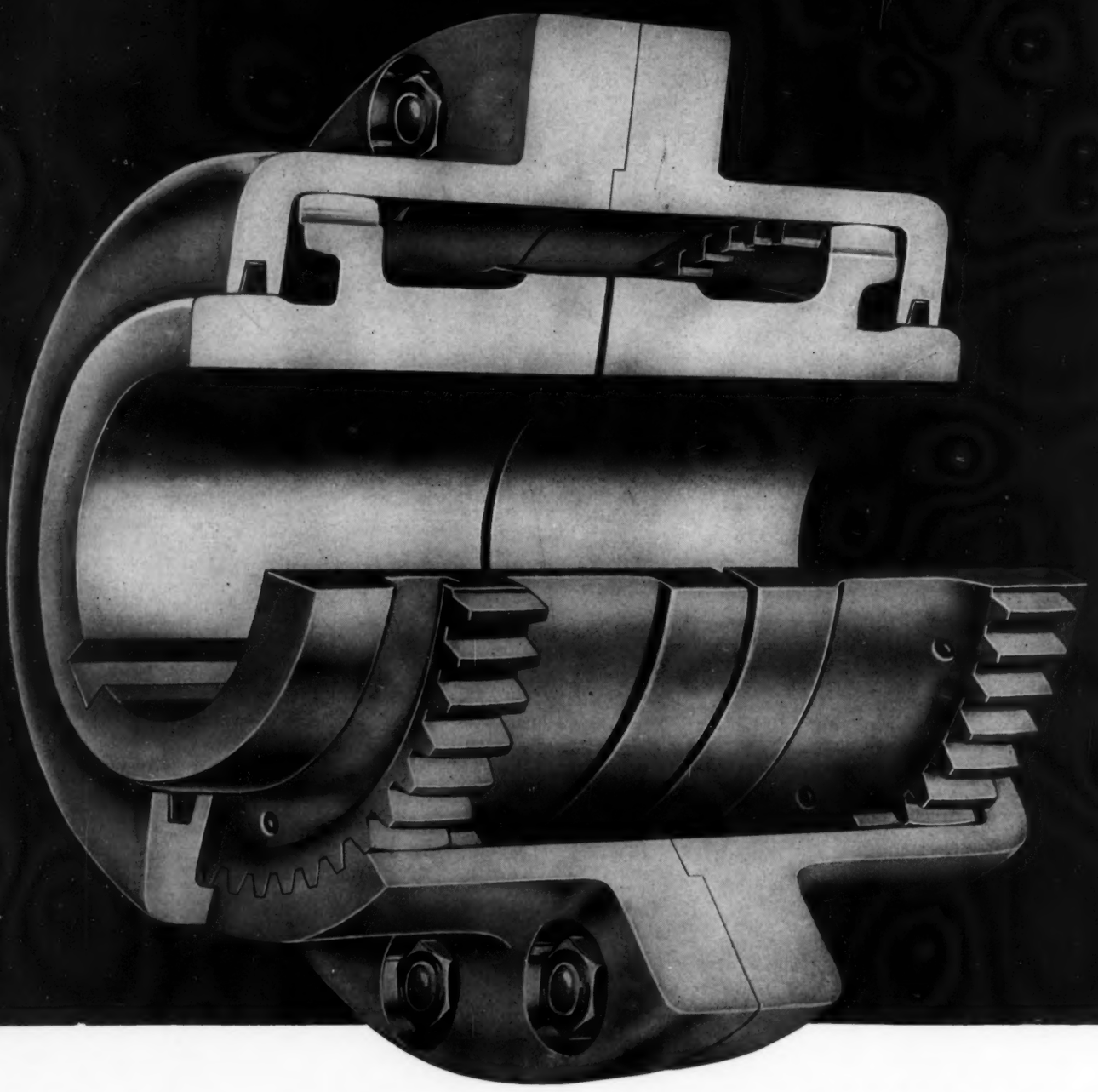
Heppenstall Forgings have a reputation for *extra* service incorporated in the vital parts of the things you make. They give you a substantial business advantage—more reliable products—more satisfied customers. Heppenstall means maximum strength and durability in alloy or carbon steel rings, back up roll sleeves, shear knives, die blocks or alloy bands . . . In your own production equipment, Heppenstall Forgings cut operating costs—another important business advantage that you can gain *immediately*. Write for quotation and details.

Heppenstall Company, Department TP, Pittsburgh, Pa.

Makers of Heppenstall Automatic Safety Tongs

Heppenstall Company

POOLE

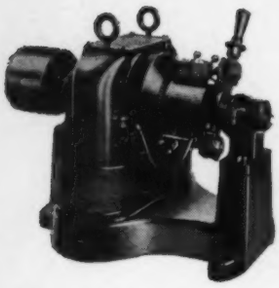


A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

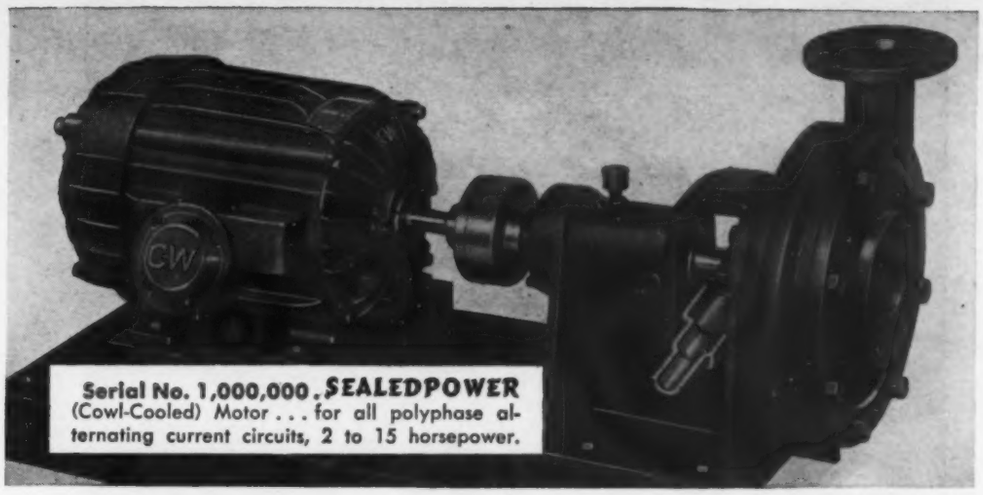
FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

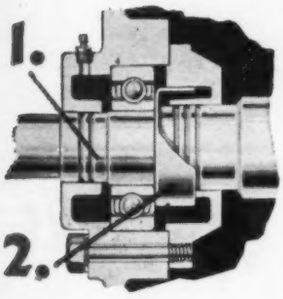
WOODBERRY, BALTIMORE, MD.

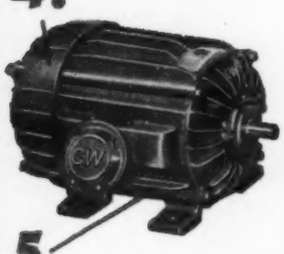


Serial No. 1 . . . Crocker-Wheeler Motor, built in 1888.



Serial No. 1,000,000. SEALEDPOWER (Cowl-Cooled) Motor . . . for all polyphase alternating current circuits, 2 to 15 horsepower.





SEALEDPOWER

Industry's Most Trouble-Free Motor

PRODUCED BY CROCKER-WHEELER'S 56 YEARS OF EXPERIENCE

CROCKER-WHEELER FEATURES:

1. Patented "Groovseal"—no greasing needed for at least a year. Grooves minimize grease loss. This seal makes bearing maintenance expense negligible. It permits use of softer grease, for better lubrication and longer bearing life. Airtight seal prevents dust or other foreign matter from entering bearings.

2. Crocker-Wheeler's exclusive De-Sludging Impeller. Automatically desludges . . . churns and distributes grease to bearings when motor is started.

3. Vacuum Impregnation—standard on *all* Crocker-Wheeler motors. Seals out foreign matter and moisture from each individual coil . . . fills all interstices, making windings a homogeneous mass . . . reduces hot-spot temperature and lengthens insulation life. Adherence of varnish prevents vibration of wires either inside or outside of slot. (Photograph shows cross sections of baseballs, (left) after vacuum impregnation and (right) before vacuum impregnation. Note penetration of varnish to center of tightly-wound ball, making it a moisture-proof, homogeneous mass.)

SEALEDPOWER FEATURES:

4. Totally Enclosed Cowl-Cooled Construction resists corrosion. Protects against acid or alkali fumes, splashing or dripping liquids, air-borne moisture, steam, corrosive gases, conducting dusts, metallic chips, etc.

5. Fin Type Construction for non-clog ventilation and easy cleaning.

WRITE FOR LITERATURE ON THE **SEALEDPOWER** MOTOR, WHICH IS WINNING THE PREFERENCE OF MACHINERY MANUFACTURERS AS WELL AS OF MOTOR USERS. OR CALL OUR NEAREST OFFICE.

CROCKER-WHEELER Motors-Generators

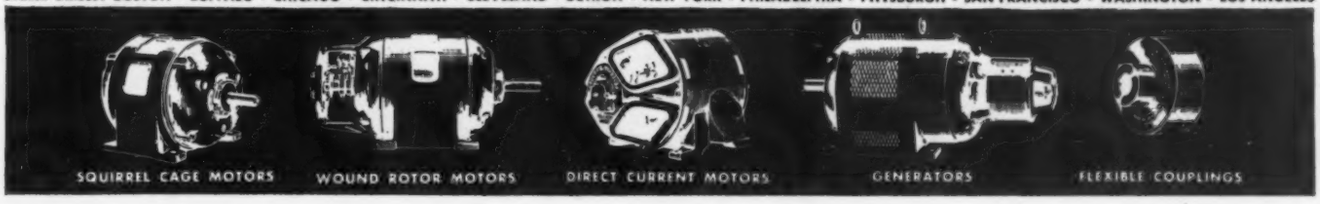
JOSHUA HENDY IRON WORKS

CROCKER-WHEELER DIVISION

ESTABLISHED 1856

AMPERE, NEW JERSEY

Branch Offices: BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • DETROIT • NEW YORK • PHILADELPHIA • PITTSBURGH • SAN FRANCISCO • WASHINGTON • LOS ANGELES



No . . . we don't make tea strainers

. . . but we *do* make them possible.

The lowly tea strainer consumes about 5 million miles of wire a year. It retails for a dime, costs the wholesaler about a nickel—and its profit demands accuracy in every operation.

Where do we come in? *With uniform accuracy at the very beginning.* We build rolling mills that roll the wire rod at speeds in excess of 4,000 F.P.M., with a uniform cross-section ±.005 in.

MORGAN CONSTRUCTION COMPANY
WORCESTER, MASSACHUSETTS

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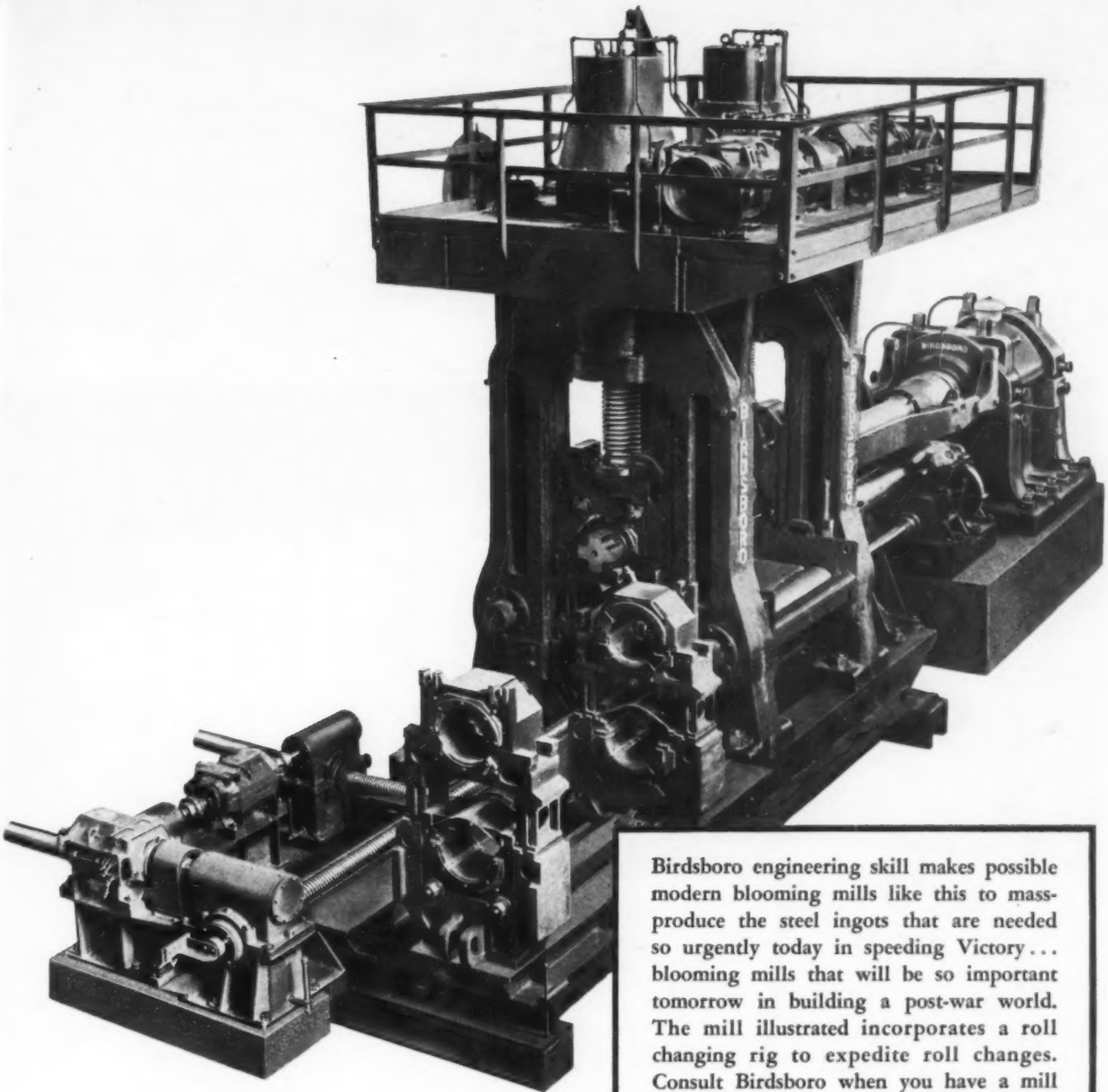
PLAN NOW WITH **MORGAN**

ENGINEERS AND BUILDERS OF ROLLING MILLS . . . WIRE MILLS . . .
GAS PRODUCER MACHINES . . . REGENERATIVE FURNACE CONTROL



Birdsboro engineering skill makes possible modern blooming mills like this to mass-produce the steel ingots that are needed so urgently today in speeding Victory... blooming mills that will be so important tomorrow in building a post-war world. The mill illustrated incorporates a roll changing rig to expedite roll changes. Consult Birdsboro when you have a mill equipment or special machinery problem.

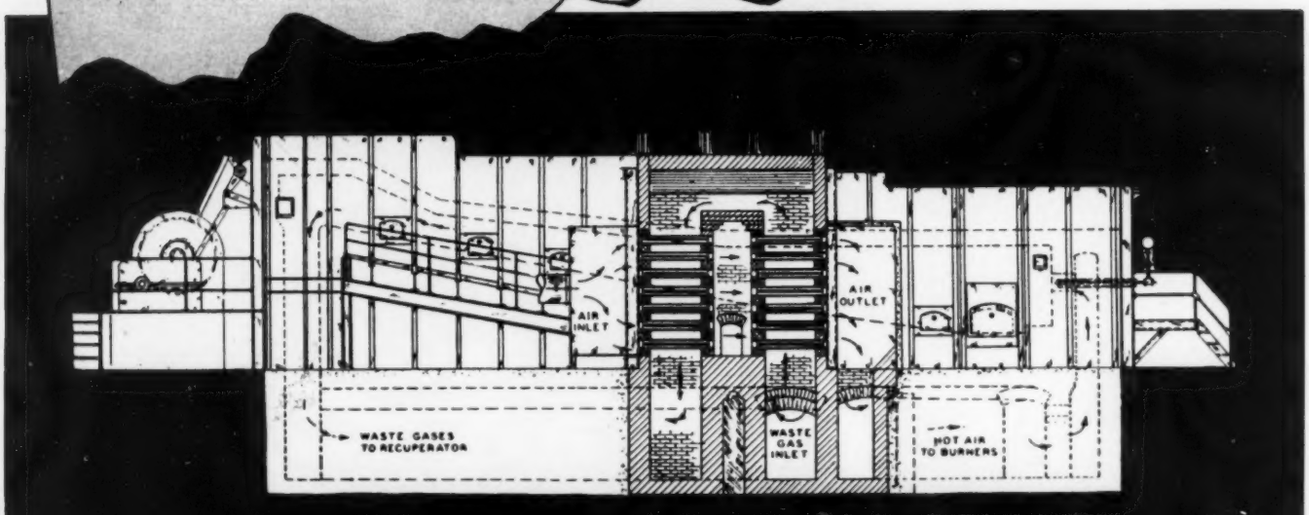
BUY WAR BONDS

BIRDSBORO STEEL FOUNDRY & MACHINE COMPANY • BIRDSBORO, PENNSYLVANIA

BIRDSBORO

STEEL MILL EQUIPMENT

14 LARGEST STEEL MILLS USE *Fitch Recuperators* in 58 Continuous Re-Heating Furnaces



Two Pass Recuperator on Continuous Furnace in Rod Mill.

TYPES OF MILLS SERVED

- STRIP MILLS
- STRUCTURAL MILLS
- WIRE MILLS
- ROD MILLS
- SLAB MILLS
- BILLET MILLS
- TUBE MILLS

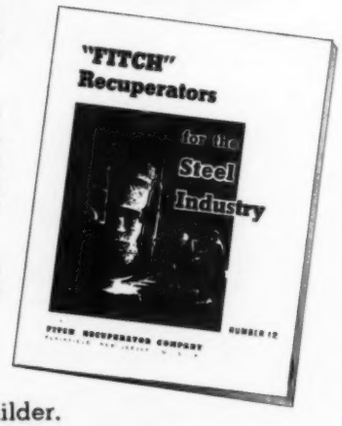
In one huge plant where two furnaces were installed, two different kinds of recuperators, one a Fitch, were used. After four years' operation the Fitch Recuperator proved so much more satisfactory than the other that it was replaced by a second Fitch Recuperator. Subsequently Fitch Recuperators were installed in two more furnaces in this same nationally famous plant.

America's leading steel mills find that with Fitch Recuperators very little time is lost on repairs. The life of the Fitch is extended over a long period of time because of the ease of locating injured tubes and their replacement in a few hours' time.

Our Booklet No. 12 shows plans and elevations on many types of installations. It is free. Write for it today.

FITCH RECUPERATOR COMPANY
Plainfield, N. J.

Write for Booklet



We do not build furnaces — see your furnace builder.

"FITCH" Recuperators

PLAINFIELD, NEW JERSEY, U. S. A.

NEWS SUPPLEMENT August, 1944

Equipment
Personnel
Literature

Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

INDUSTRIAL HYGIENE IN HOT WEATHER INCREASES PRODUCTION EFFICIENCY

▲ The high temperatures of the summer months bring with them a number of hygienic problems in industry. The comfort and health of workers, as well as efficiency in production, depend to a considerable extent on the degree to which hot weather conditions are controlled.

In the hot summer months, a real contribution can be made to the comfort and efficiency of workers by maintaining as high a ventilation rate as feasible, with the rate of air movement within the workroom high enough to cool the occupants by rapid evaporation of their perspiration. Where air conditioning is used in product control, with necessary heat or humidity resulting in damp clothing at the end of the work day, provisions for showers and a change of clothing at the end of the shift are desirable.

In operations involving the use of organic solvents, care must be taken to prevent changes in the ventilation rate from causing the solvent vapors to escape into the workroom atmosphere in concentrations above those known to be safe.

Since many organic solvents are of high volatility, those which may be used safely in cool atmospheres may form excessive concentrations of vapor in hot atmospheres, unless exhausted. Efficient local exhaust ventilation will solve this problem. In operations where the solvent is used intermittently or in small amounts, open windows may provide sufficient ventilation for safety, depending upon the nature of the solvent. However, where local exhaust ventilation is provided for safe use of solvents in tanks, employees generally should not be allowed to open windows; the currents of air thus created may disperse unsafe amounts of vapor into the workroom atmosphere, or, if the solvents used are flammable, may increase the hazards of fire and explosion. In such instances, to maintain a comfortable as well as safe workroom atmosphere, general exhaust should be provided, in addition to local exhaust.

Unqualified employees should not be allowed to tamper with ventilating devices provided for safety, or shut them off, as occasionally happens because some individuals prefer the natural ventilation of open windows.

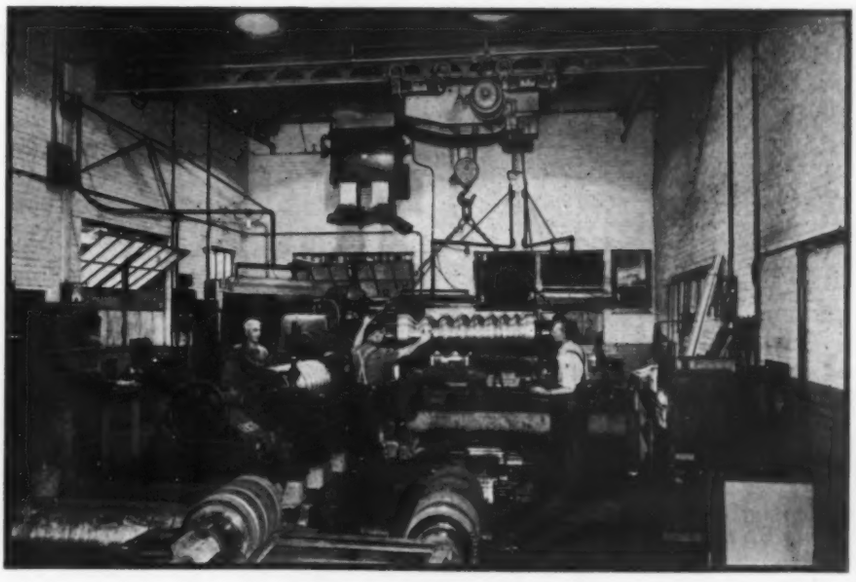
These same rules on ventilation generally apply also where potentially harmful metal fumes, gases, mists or dusts are controlled.

Industrial dermatitis or skin affections from contact with irritating substances used in industry are more prevalent in the summer months. This problem can be met by minimizing contact with the irritating substance, either by hoods or other mechanical means; by requiring increased personal cleanliness (which implies the supplying of enough washstands or showers, and sufficient hot water and soap); by use of protective clothing impervious to the irritating substance; and by use of protective hand creams.

In plant cafeterias, added care should be observed in the handling and refrigeration of food, and strict attention should be paid to sterilization of dishes and utensils.

FLOOR OPERATED ELECTRIC HOIST FOR ROLL SHOP

A five-ton hand-propelled Cleveland Tramrail crane, with floor operated electric hoist, serves the roll shop in the new Brigham Road plant of Allegheny-Ludlum Steel Corporation at Dunkirk, New York.



Drinking water should be between 40 F and 80 F, preferably around 50 F. Salt and dextrose tablets are placed beside drinking fountains in a number of industries to prevent heat exhaustion, especially where physical exertion and consequent heavy perspiration tend to decrease the normal salt supply of the body.

In both atmospheric and plant sanitation, there are three important steps to be observed: (1) provide efficient ventilation and operating equipment that not only serves its industrial purpose but protects the worker; (2) maintain these facilities in proper condition; and (3) educate workers in the proper use of these facilities, and in the "healthiness" of personal cleanliness.

More complete information on this subject is contained in the "Manual of Industrial Hygiene," published by the U. S. Public Health Service.

NEW COKE PLANT FOR JONES AND LAUGHLIN

▲ Construction of a new seven-and-one-half million dollar battery of 106 by-product coke ovens has been started at the Aliquippa Works of the Jones and Laughlin Steel Corporation.

Prompted by record demands for war steel and important chemical by-products the company has let a contract for the new ovens which will increase its capacity for making metallurgical coke approximately 59,000 tons per month. This represents a fifty percent increase in the coking capacity of the Aliquippa Works and a twenty percent increase in the company's overall coking facilities.

In addition to producing the increased coke to be used as fuel in blast furnaces to make iron, the company will recover large additional quantities of by-product chemicals. These include benzol and tar products vital in making munitions, paints and plastics; medicines, such as sulfa drugs, and fabrics such as nylon. Existing J & L by-product recovery equipment, with some slight addition, has the capacity to handle the increased flow of by-products.

The contract for the ovens has been let to the Koppers Company of Pittsburgh and it is expected the project will be completed in fourteen months.

OLD PIPE AND TUBING RECLAIMED BY POWER DRIVEN WIRE BRUSHING WHEELS

▲ One of the oldest and simplest power brushing operations, that of metal cleaning by wire brushing wheels, has become increasingly important during recent months due to its widespread application in reclaiming old, rusty, discarded pipe, according to brushing engineers of The Osborn Manufacturing Company, Cleveland, Ohio.

This observation has been verified in scores of industrial concerns where the method of quick pipe reconditioning has made it possible to return hundreds of tons of critical piping material back into service.

Very little equipment is needed for the process, the only essentials being a power driven spindle and wire brushing wheels of the proper size and gauge of wire.

Typical of such installations is the one at the Builders Structural Steel Company, Cleveland, Ohio, where pipe in various sizes and lengths is power-brushed to a practically "good-as-new" finish for many kinds of industrial re-use.

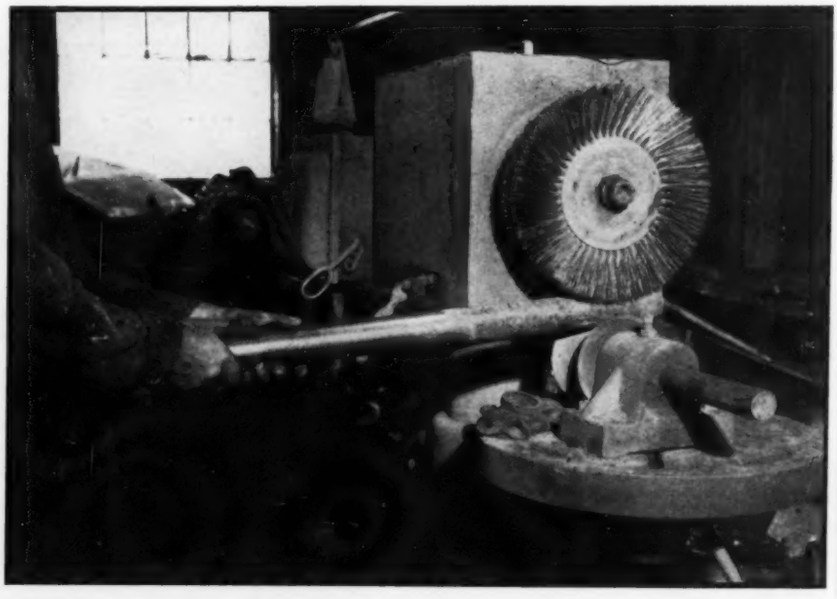
Depending upon the size of pipe being cleaned, combinations of two, three, four or more wire brushing wheels with disc center are mounted on a spindle powered by a stationary electric motor. The wire wheels, of about 33-gauge wire, revolve at a speed of 1800 revolutions per minute. Pipe is inserted between a roller mounted on the bed of the unit and the operator moves the pipe back and forth about 10 to 12 inches at a time under the revolving brushes, rotating the work slowly to clean all sides.

The roller fixture, which can be replaced with a size roller to fit the diameter of the pipe being brushed, is also adjustable by turning a hand crank on the side of the fixture so that the required pressure can be applied to thoroughly remove all rust and scale deposits. A long length of pipe is handled by placing it on adjustable roller dollies.

The thousands of strong, special quality wires which comprise the brush sections do an excellent job of cleaning and burnishing the pipe surfaces.

The company reports that this power brushing method has greatly increased output and is much more effective than previous machine methods, being at least ten times faster than hand methods. Thus, not only does this wire brushing set-up do a better cleaning job but it also releases many man-hours of labor for other essential war production duties.

Effectiveness of wire brush cleaning is evidenced in this view showing comparison of cleaned section of pipe (left) with original rusted and corroded surfaces (right) before cleaning.



GREATER UNIT LOADS

..and a safer, speedier handling and stacking system..

The "AUTOMATIC" Fork Lift Truck is an all-around fast, sure, and low-cost worker. It affords greatest flexibility whether for multi-stacking, loading, shipping, or transportation in plant or yard.

A woman can handle tons per day unassisted and through her simplified efforts inject cost-savings throughout the plant.

You conserve much needed floor space thru high orderly stacks—fully utilizing overhead space.

. . . . Write for further details on "AUTOMATIC" Fork Lift Trucks and their application to handling and stacking problems such as yours.

TRADE **AUTOMATIC** MARK
Fork Lift Trucks

MANUFACTURERS FOR OVER THIRTY FIVE YEARS *Electric Propelled* INDUSTRIAL TRUCKS

AUTOMATIC TRANSPORTATION CO.

47 WEST 87th STREET — DIV. OF THE YALE & TOWNE MFG. CO. — CHICAGO 20, ILLINOIS

NEW AUTOMATIC UNIT FOR CIRCULATING, HEATING OIL

▲ An oil heating unit has been designed by Youngstown Miller Company, Sandusky, Ohio, to provide heat transfer oil to machines which require elevated temperatures.

A typical model or size has 12.8 kw of electric heaters applied externally to the heating portion of the tanks and capacity for 12 gallons of oil. It has three thermostats, each of which can be set for a desired temperature by the user. A simple selector switch enables changing the controlled temperature from one to another by putting either of the thermostats into the electric circuit. Thus the operating temperature can be readily changed according to the requirements from day to day without resetting the thermostats.

The heated oil is circulated by a rotary pump driven by ½ hp, 1150 rpm direct connected motor and the pump is so located that any drip from the stuffing box returns to the main circulating oil pool.

A selector switch is also provided to enable operating with the circulating pump without heat; circulating pump with a portion of the heaters; and thirdly, circulating pump with all of the heaters. Lighted jewels signal the setting which the operator is working with at any particular time. A float inside of the heating tank indicates visibly the level of oil. A thermometer shows the temperature. Provisions are made to minimize the contact of the oil with air so as to reduce the tendency for oxidation. By suitable adjustments of the thermostats any three temperatures can be pre-selected between 200 F and 500 F, inclusive.

STORAGE BATTERY OFFERS 30% LONGER LIFE

▲ A new industrial truck storage battery with 30 per cent longer life has just been announced by M. W. Heinritz, vice president in charge of the Storage Battery Division of Philco Corporation. Named the "Philco Thirty", this battery is said to incorporate a revolutionary new principle of fabricated glass tape insulation which greatly lengthens the efficient service life of the battery's power-producing positive plates.

In the new Philco Thirty glass mats have been replaced with a jacket of glass tape insulation which completely encases the positive plates. The tape is wrapped around the plates in a double layer, one horizontal and the other vertical, both with ample overlap to assure a homogeneous film.

Even a single layer of this glass tape has been found to have better retentive power in holding the active material in the plate, than the standard glass mat. Moreover, by completely encasing the grid frames, the rate of peroxidation of these grids is materially decreased. In both respects, battery life is lengthened.

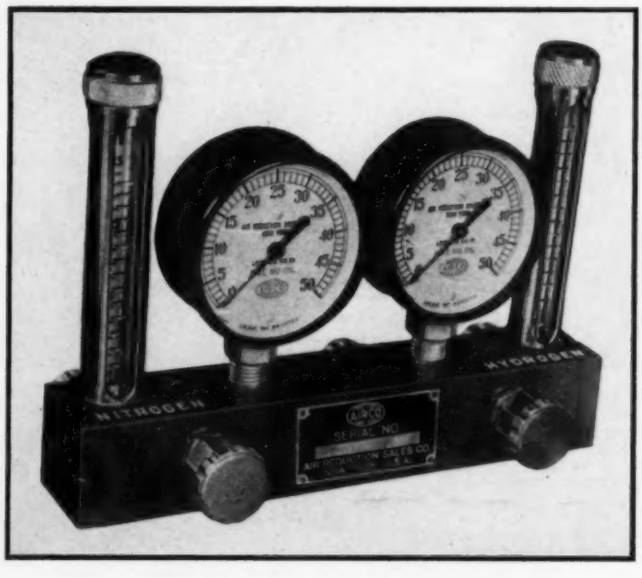
This innovation in battery construction has proved itself not only in the laboratory, but in actual field service. Tests of the Philco Thirty in industrial trucks and in other motive power applications have been going on continuously since 1938, and in the laboratories since 1936.

At present, this new battery is available in certain sizes and limited quantities, but with the easing of wartime restrictions the line will be developed to include types and sizes for all battery powered industrial truck equipment.

GAS MIXER CONTROL FOR PROTECTIVE ATMOSPHERES

▲ The new airco gas proportioner was developed in Air Reduction Sales Company's research laboratories to meet the demands of electronic tube manufacturers, heat treaters and others who use mixtures of gases for protective atmospheres. It is designed to produce an accurately proportioned mixture of such gases at a pressure not in excess of 5 psi.

This new device consists of a mixing block incorporating accurately sized orifices and on which are mounted flowmeters, pressure gauges and needle valves for the gases as well as inlet and outlet nipples. It can be furnished with any two of six available flowmeters permitting a wide variation in the proportions of the two gases to be mixed. Flowmeters for hydrogen service cover a range from approximately 2 to 200 cubic feet per hour and for nitrogen the range is from approximately 6 to 140 cubic feet per hour. The gases should be supplied through two-stage regulators capable of delivering the required volume at pressures from 10 to 25 lb.



This mixing block, with flowmeters, pressure gauges and needle valves, provides complete control over the proportions of two gases to be mixed.

NEW PLANT FOR SHEAR KNIFE MANUFACTURE

▲ The Wapakoneta Machine Company of Wapakoneta, Ohio are constructing a new and more modern plant which is now nearing completion. This new plant will be the most modern knife plant in the United States for the production of all kinds of machine knives, shear blades, and circular slitters, fire-proof from every conceivable angle and with maximum ventilation.

Wapakoneta officials say that their capacity for producing slitters will be increased between 200 and 300 per cent while the production facilities for producing all types of knives will also be increased.

The Wapakoneta Machine Company have for years been specialists in the art of producing machine knives, and with new and modern machinery of the latest type along with the latest innovations in heat treating facilities are one of the most outstanding producers of this equipment.

Present orders from all parts of the world seem to indicate that they are entering into an era of international business.

ELECTRICAL MANUFACTURER ANNOUNCES NEW PRODUCTS

▲ Following the trend toward oil elimination in indoor switchgear equipment, a new "Ruptair" magnetic type air circuit breaker has been developed by Allis-Chalmers, Milwaukee, Wisconsin, and is now available in high voltage, oil-less switchgear rated 5000 volts and below and 150,000 kva interrupting capacity and below. The "Ruptair" breaker has overall dimensions as compact as standard oil breaker switchgear, with all parts readily accessible.

In the new air breaker the arc chute has been carefully coordinated with the contact and arc runner design to give consistent and reliable interruption through the entire range of current to be interrupted. The magnetic circuit, consisting of one husky blowout coil and two laminated iron pole pieces per phase, is arranged to force the arc up into the arc chute immediately upon separation of the arcing contacts.

Complete inspection and maintenance of the self-contained contact assembly can be accomplished without disturbing the arc chute or magnetic circuit in any way.

Also announced by the company is a new magnetic, reduced voltage cage motor starter, which protects motors from sustained overloads, locked rotor condition, single-phasing and overloading from too frequent starting. This is accomplished in the new starter (called type "ARC") with an accurately calibrated, thermal overload relay. Built for general industrial applications, the new starter is now available for control of motors from 5 to 2500 horsepower, up to 5000 volts, 3-phase, 50 or 60 cycles.

Reduced voltage, two-point starting is obtained with a built-in autotransformer, utilizing accurate, synchronous motor-driven, adjustable timing relay for transition from starting to running position. (Units rated through 800 hp have built-in autotransformers; above 800 hp, autotransformers are furnished for separate mounting.) Interrupting capacity rating of the new starter is ten times the motor's full load current.

Standardize on CONDULETS!

You can meet every need from a single source—the world's largest manufacturer of electrical conduit fittings.

CONDULETS are made only by CROUSE-HINDS

A few of the many CONDULETS for non-hazardous locations

CONDULETS — the complete line — engineered to enable the electrician to do the job and do it right. There is a type for every purpose.

Arktite circuit-breaking plugs and receptacles.

Vaportight Condulets for use where exposed to weather, moisture, steam or non-combustible dust.

Dust-Tight Condulets for use where combustible dust creates hazardous conditions.

Explosion-Proof Condulets for use in locations that are hazardous because of the probability of the presence of flammable gases or vapors.

A Nationwide Distribution Through Electrical Wholesalers

A few of the many CONDULETS for hazardous locations

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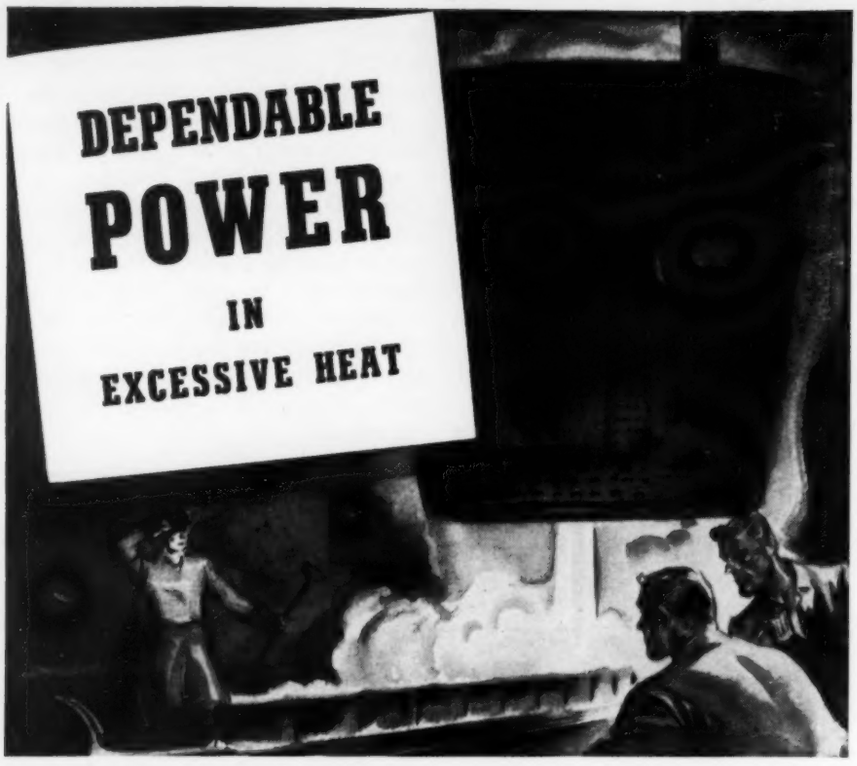


with DELTABESTON

Deltabeston *Asbestos*-insulated Power Cables are designed for control, lighting and power circuits where severe service conditions prevail. Mill operators rely on Deltabeston for wiring around kilns, soaking pits, furnaces, boiler rooms and in other torrid zones. They know where excessive heat is the predominant factor, Deltabeston *Asbestos*-insulated Power Cables provide the utmost in service. Deltabeston not only successfully resists heat but moisture, oil, grease and most corrosive vapors.

For additional information write to Section Y742-31, Appliance & Merchandise Dept., General Electric Co., Bridgeport, Conn. Deltabeston Asbestos-insulated Wires and Cables are distributed nationally by Graybar Electric Co., G-E Supply Corp. and other G-E Merchandise Distributors.

1. Copper conductor is centered perfectly providing uniform thickness of the insulating wall.

2. Impregnated felted asbestos is a heat barrier for protection against high conductor temperatures.

3. Varnish Cambric gives moisture resistance and high dielectric strength.

4. Felted asbestos provides plus protection against high ambient heat.

5. Asbestos braid for high resistance to heat, moisture, oil, grease and most corrosive vapors.

Hear the General Electric radio programs: "The G-E All Girl Orchestra" Sunday 10 P.M. EWT, NBC; "The World Today" news every weekday 6:45 P.M. EWT, CBS

BUY WAR BONDS AND KEEP THEM

GENERAL ELECTRIC

INLAND SETS RECORD IN BLAST FURNACE OPERATION

▲ A new record in continuous group operation of blast furnaces has been established at the Indiana Harbor plant of the Inland Steel Company where five furnaces have maintained uninterrupted production for more than four years.

Last year it was considered noteworthy when the five furnaces had completed three years of uninterrupted group production. With another year of service added without a shutdown the record of the group of furnaces is considered remarkable.

The five blast furnaces at Indiana Harbor have been operating at maximum capacity since August 6, 1940 when No. 2 furnace was blown in, each producing about 1000 tons of much-needed iron daily for the war program.

Company officials explained that a continuous push for production exacts a toll from blast furnaces which generally necessitates shutting them down for relining or rebuilding. The former is a two-month job and rebuilding ordinarily takes five months.

Even before Pearl Harbor, Inland officials visualized that there would be need for continued maximum production. Privately financed and with a capacity of 1200 tons of iron per day, a sixth furnace was built to insure against loss in production. It was blown in on November 16, 1942. Since that time the company has been benefiting also from the steady operation of No. 6.

STORAGE BATTERY HAS NEW DESIGN FEATURES

▲ With the famous Exide-Ironclad battery at peak production, The Electric Storage Battery Company has made available the new Exide-Powerclad battery. This new Exide supplements the production of Exide-Ironclads to relieve shortages. It meets the most exacting requirements encountered in motive power service. The Exide-Powerclad battery is the result of 12 years of research devoted

to developing a specific battery for motive power requirements.

The Powerclad embodies an exclusive design of the positive assembly. It is a plate completely enclosed by a slotted polystyrene retainer. In combination with the separators, it assures effective retention of the active material, and provides rapid diffusion of the electrolyte. This assures long life and capacity discharges at usable voltages throughout the life of the battery.

The many exclusive features of this newest Exide combine to produce a motive power battery that provides maximum capacity in minimum space consistent with the fundamental requirement of long life expectancy in order to assure economical operation. It is a fitting companion to follow through on the 34 year success of the Exide-Ironclad, and it can be counted on to uphold the tradition of performance inherently a part of the name Exide.

TWO ELECTRIC-WELDED PIPE MILLS FOR RUSSIA

▲ One of the most interesting groupings of machinery produced by a single plant in recent months has just been completed by The Yoder Company of Cleveland, specialists in metal forming equipment. Two complete mills for the production of 1½ in. to 6 in. resistance weld steel pipe, each of which makes a production unit about a quarter of a mile long, were built for Russia, involving erection of each entire mill and its operation as an assembled unit in the Yoder plant before shipment. The first of the mills, which are identical twins, already has been viewed, torn down and shipped; the second is currently being assembled.

Notable among the features described by the company as new and exclusive is the 750 kva a-c welder, with an ingeniously mounted close-coupled electrode and transformer assembly. The wheel type electrodes are mounted directly to the transformer, which revolves with them. Unusually short travel of welding current is achieved. The welder is compactly assembled, affords ready access to the guide roll and electrode adjustments and the electrode dressing tool, which provide for convenient adaptation of the machine to the various pipe size within the range of the mill.

Individual machines which make up the complete mill are a heavy duty coil box, a leveler, a side trimmer, shot blasting equipment, an eleven-stand tube forming mill, the electric welder with complete controls, a cooling trough, a three-stand sizing mill, a flying rotary cut-off, and a runout table and kick-off.

The rest of the equipment consists of cross-roll straighteners, hydrostatic testing machines, washing, drying and painting machines, stationary cut-off machines, double-end burring machines, threaders, coupling borers, coupling tappers, and coupling screwing-on machines, providing the means to make everything complete except special fittings. A roll grinder for reconditioning mill rolls also is provided, as well as a 1000 kw motor-generator set to provide direct current for certain mill units.

BETTER PRODUCT CONTROL is possible with Hays Draft or Pressure Recorders which are a positive guide to balanced draft conditions in soaking pits, open hearths, slab mills, annealing and other furnaces. They eliminate guesswork, save man power and reduce rejects to the minimum. They are a real help in the all-out effort for bigger and better steel production.

The ten-inch, 24 hour charts give a permanent record of day in and day out performance of every furnace. Two draft values, two pressure values, two differential values or any combination of two of these three values may be recorded. Or temperature may be included if desired and mercury switches may be provided to operate an alarm or a power unit to open and close a damper, etc.

Any way you look at it, the Hays Series OT Draft Recorder is a Guard over furnace operation and merits your investigation. ***Write for Bulletin 39-232.***

The HAYS CORPORATION
SINCE 1901
COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A.

New Literature

▲ The problem of selecting the proper bucket to meet the operating requirements when single drum hoists and hook-on applications are involved is greatly simplified by a Blaw-Knox catalog recently published. It takes the guess-work out of the problem of selecting the proper bucket for a particular job and amply classifies the different types and their uses. Each type of application is classified into the following four groups: How to select; typical method of installation; table of sizes; and typical illustrations.

The illustrated 48-page booklet may be secured by requesting Blaw-Knox Division of Blaw-Knox Company, P. O. Box 1198, Pittsburgh, Pennsylvania, for a copy of their catalog No. 2002.

▲ Two new technical bulletins have been published by the Bloom Engineering Company, 857 W. North Avenue, Pittsburgh 12, Pennsylvania. One, "Bloom Butterfly Valves," illustrates the engineered reduced port valve construction with manual hydraulic or electric motor operation. The company states that the reduced port design avoids accumulation of dirt at the valve seat and permits selection of a port size to suit flow requirements regardless of valve or body size. Close machining provides for 40 to 1 turn-down range. Construction features, mounting specifications and other technical data are given.

The second bulletin (No. 1230) describes Bloom clean producer gas burners for Galusha producer gas, blast furnace gas, mixed blast furnace and coke oven gas. These burners are stated to provide quick, even combustion of slow burning gases. Thorough mixing of air with the gas insures uniformly good results. For high temperature applications, preheated air and gas are used. Among other information given is data on design and construction, dimensions, application recommendations and adaptability to auxiliary fuels.

Copies of both bulletins are available through this publication or direct from the manufacturer.

▲ Catalog section M-8802, "Karbate Corrosion Resistant Heat Exchange Equipment," sets forth several charts and tables covering the heat conductivity and the physical and chemical properties of carbon, graphite and "Karbate" materials. It contains a great many illustrations and drawings indicating the versatility of these materials in the design and execution of an extensive variety of heating and cooling units. Copies are available upon request to National Carbon Company, Inc., 30 East 42nd Street, New York, New York.

▲ Catalog No. 300 issued by The Cleveland Worm and Gear Company, Cleveland, Ohio, is a comprehensive exposition of Speedaire fan-cooled worm gear reduction units. The Speedaire principle is fully detailed by means of cutaway photographs, charts, diagrams and engineering tables.

With Speedaire, heat generated during the operation of the unit passes through the oil bath to the deeply-finned wall of the reservoir. An exhaust fan on the coupling end draws a continuous stream of air at high velocity between the double walls that form the lower half of the unit, completely scouring the surface and providing an effectual transfer of heat.

The catalog states that as the result of this improved cooling, smaller sizes of Speedaire units may be applied to a given installation than have been possible heretofore. In some cases it is claimed that the new units offer as much as twice the capacity of standard worm gear units of equal frame size when operated with 1750 rpm motors.

Following the explanatory and descriptive material which comprises the first portion of the book, the design engineer will find carefully detailed instructions for planning installations of Speedaire units, with illustrative examples. Supplementing these instructions are rating tables for six sizes ranging from 4¾in. to 12 in. centers. Full information is also provided on dimensions and shipping weights.

▲ Four bulletins recently released by the William M. Bailey Company, Pittsburgh, Pennsylvania, describe some of the various blast furnace equipment made by the company. Described are the Bailey cold blast valves, mixer and check-relief valves, snort valves, and blow off valves.

▲ Anyone who aims at top production from open-hearth furnaces, by running them at the top safe temperature, without endangering the roof, should be interested in a completely revised bulletin, "Limiting the Temperature of Open-Hearth Roofs," just issued by Leeds and Northrup Company to show how O-H men may have all the benefits of the well-known Micromax Electric Control, applied now to roof temperature.

This system — actuated by a Rayotube detector sighting directly on the furnace roof — automatically maintains desired temperature by continuously regulating fuel input.

The system is said to be easy to operate, is built for rough service, requires little maintenance and is easy to install. For more complete information, write for Bulletin N-33B-643(1), "Limiting the Temperature of Open-Hearth Roofs," Leeds and Northrup Company, 4934 Stenton Avenue, Philadelphia 44, Pennsylvania.

▲ How centralized lubrication systems increase the production output of machinery and at the same time make impressive savings in time, power and lubricating materials, is the theme of bulletin No. 25, newly published by The Farval Corporation, Cleveland, Ohio. This 16-page booklet, printed in three colors, is a graphic portrayal of the theory and practice of mechanical lubrication. It opens with a study of the machinery lubrication problem and of the economies that are inherent in a system which delivers lubricant to all bearings in exact measured amounts regardless of location. This information is faced by a large close-up of a Farval Manual Dualine system at work. There follows an explanation, by means of six cutaway drawings in color, of how the Farval measuring valve operates to deliver a measured amount of lubricant, and why it can do this without recourse to springs, check valves or small ports. The construction and operation of both manual and automatic pumping units, which provide the high pressure source of lubricant supply, are similarly treated. The center spread is devoted to the economics of positive mechanical lubrication; and in the concluding pages a selection of 24 application photographs suggests methods of locating and mounting

More Power to You!

And *greater earnings for you,* too—because the new Cleveland Speedaire Worm Gear Unit gives you *More Horsepower for Your Dollar!*

Speedaire—the new Fan-Cooled Worm Gear Reducer—offers as much as twice the capacity of standard worm units of equal frame size, when operated at usual motor speeds. Heat generated during operation is literally *scoured off* the outer surfaces of the oil reservoir by a high-velocity air stream.

The greatly-increased capacity of the new Speedaire will permit you to use these Units in place of other types—giving you all of the inherent advantages of a right-angle worm drive.

Write for your copy of the new Speedaire Catalog. The Cleveland Worm & Gear Company, 3278 East 80th St., Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication
In Canada: PEACOCK BROTHERS LIMITED

pumping units and feed lines on as many different kinds of machinery.

▲ Two new bulletins just released by Surface Combustion for the metal-producing and metal-working industries are available to interested persons upon request. One (Form SC-117) is entitled "Surface Combustion Furnaces in the Steel Wire Industry," while the other (Form SC-118) deals with "Applied Gas Chemistry of Prepared Atmospheres in Surface Combustion Furnaces."

▲ Cochrane Corporation, Philadelphia, has just issued a publication (No. 4071) on the new Cochrane boiler ratio meter, announced last month. Introductory pages describe methods of checking combustion efficiency in boiler plants. Then follow the requirements for an ideal boiler meter, and the detailed description of the Cochrane boiler ratio meter which it is claimed completely meet these ideal requirements. Installation details are also given.

▲ A new line of smooth-flowing arc welding electrodes with quiet arc characteristics has been announced by the Allis-Chalmers Manufacturing Company. The new electrodes, both a-c and d-c types, use the standard American Welding Society number and color, simplifying selection and handling. A new bulletin, B6340, describes the electrodes. It includes a price sheet, zone classifications, freight policy, quantity discounts, and term explanation. Write Allis-Chalmers, Milwaukee 1, Wisconsin.

▲ A 20-page booklet entitled "Evaluating Apprentices," meets a long-felt need for technical advice on how to determine the cost of training apprentices, as compared with the value of their production while in training; as well as how to record the skills apprentices acquire as they advance from one step of their training to the next. It has been prepared especially for training directors and others responsible for apprentice training. These pertinent questions are discussed comprehensively from the practical standpoint in two fact-finding articles contained in the booklet, entitled respectively "Cost of Training and Value of Production of Apprentices" and "Apprentice Record Cards."

Copies of this booklet may be obtained by writing to Apprentice-Training Service, Bureau of Training, War Manpower Commission, Washington, District of Columbia.

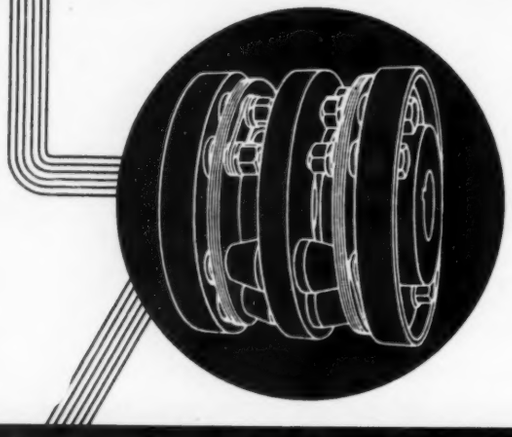
▲ A 16-page booklet which emphasizes fundamental practices for the economical use of degreasing solvents in metal cleaning departments of industrial plants and describes typical designs of degreasers has just been published by Detrex Corporation, Detroit 27, Michigan, under the title of "Solvent Degreasing and Effective Methods of Conserving Chlorinated Solvents."

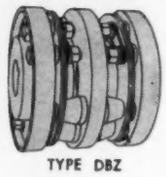
"Detrex Triad Alkali Cleaners," an 8-page booklet describes in detail alkali and emulsion cleaning compounds developed by Detrex for all types of metal cleaning jobs. It also covers the many uses and applications of alkali cleaning materials in aircraft, automotive, railroad, metal fabricating and other industries.

▲ A book of complete, up-to-the-minute information on open steel grating and stair treads has just been issued by Wm. F. Klemp Company, steel flooring specialists, 6601 South Melvina Avenue, Chicago 38, Illinois.

Profusely illustrated with photographs of the products in actual plant and building uses, it adds to detailed construction particulars, drawings, and tabular specifications, providing full installation data for every requirement.

THOMAS
Flexible COUPLINGS

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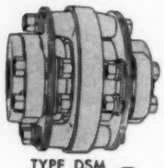
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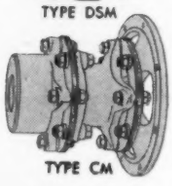
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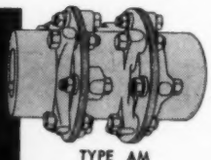
Eliminate BACKLASH, FRICTION, WEAR AND CROSS-PULL
the four destructive evils of other types and makes of couplings that prevent a permanent care-free installation.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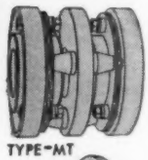
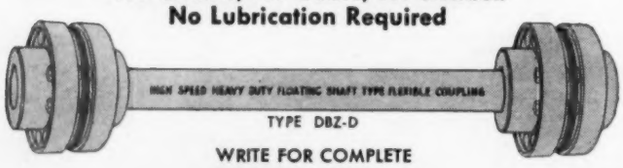

TYPE-MT

The Thomas All-Metal Coupling has:
No Chains, No Gears, No Rubber.
No Lubrication Required



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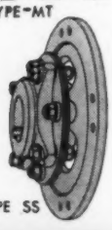
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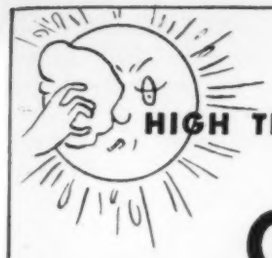
WRITE FOR COMPLETE ENGINEERING CATALOG

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA



HIGH TEMPERATURES MOISTURE CORROSIVE FUMES

CAUSING WIRE-FAILURES?

THE ROCKBESTOS CONSTRUCTION THAT PROVIDES LONG WIRE LIFE

Rockbestos A.V.C. Power Cable, above, and similarly insulated Motor Lead Cable (Underwriters' and Nat. Elec. Code, Type AVA) has a maximum operating temperature rating of 110° C. (230° F.) and this permanently insulated construction:

1 The conductor is perfectly and permanently centered in helically applied insulation.

2 Felted asbestos insulation, impregated with heat, flame and moisture resisting compounds, withstands conductor heating overloads and won't dry out, bake brittle or burn.

3 Lubricated varnished cambric for high dielectric strength and added moisture resistance, protected from heat, flame and oxidation between two felted asbestos walls.

4 Outer felted asbestos wall, also impreganted with heat, flame and moisture resistant compounds, serves as an effective barrier against high ambient temperatures and flame.

5 A tough, rugged asbestos braid, resistant to heat, flame, moisture, oil, grease and corrosive fumes.

One of 122 different wires and cables developed for severe operating conditions by Rockbestos.

WON'T bake brittle, bloom, burn or rot — resists moisture, oil, grease and fume

ROCKBESTOS A.V.C. 600 VOLT BOILER ROOM WIRE
(Underwriters' Type AVA)

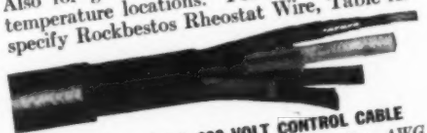
Sizes No. 18 to 4/0 AWG. This construction for sizes 18 to 8, sizes 6 to 4/0 have another wall of felted asbestos next to the conductor.

For lighting and control circuits exposed to heat and moisture, oil, grease, corrosive fumes or fire hazard, such as exist around furnaces, ovens, lehrs, soaking pits, boilers, etc., this widely used A.V.C. construction is ideal. Also for locomotive panel wiring and for switchboards requiring an asbestos braided wire.

ROCKBESTOS 600 VOLT ALL-ASBESTOS RHEOSTAT CABLE
(Underwriters' Type AI)

Sizes No. 18 AWG to 1,000,000 CM insulated with a heavy wall of felted asbestos, covered with a rugged asbestos braid finished in black, white or colors.

Use this power and rheostat cable for wiring rheostats, switchboards, elevator and locomotive control panels and electrical equipment exposed to heat, fumes and fire hazard. Also for general open wiring in dry, high temperature locations. For solid conductor specify Rockbestos Rheostat Wire, Table A.



ROCKBESTOS A.V.C. 600 VOLT CONTROL CABLE

In one to 19 conductors. Standard stranding AWG No. 12—19/No. 25 and No. 9—19/No. 22. Other strandings furnished.

Designed for use under conditions too severe for control cables with other types of insulation which deteriorate rapidly when exposed to high temperatures. Operates without failure under the attack of heat, oil, grease or corrosive fumes and may be installed in conduit as it has ample moisture resistance.

Install ROCKBESTOS A.V.C. for trouble-free wire Performance

If you are having repeated wire-failures in electrical circuits that run around furnaces, lehrs, kilns, steam tunnels, soaking pits . . . places where wire insulation is exposed to excess heat, moisture, corrosive fumes, and other destructive elements . . . then install Rockbestos A.V.C.—the wire with the *permanent insulation* and a maximum operating temperature of 230° F.

Rockbestos A.V.C. stands up where other wires fail because its *permanent* asbestos — varnished cambric insulation and heatproof, flame-proof, moisture-resistant asbestos braid won't bake brittle, dry out, crack, bloom, rot or swell under heat, vibration, alkalies, oil, grease or corrosive fumes.

Prevent repeated wire-failures and equipment shut-downs . . . wire all "hot-spot" locations with Rockbestos A.V.C. 122 standard constructions are available to fit practically every service requirement. When inquiring or ordering, please furnish CMP allotment number or symbol and certification. For complete information and samples, write nearest branch office or:

Rockbestos Products Corporation, 953 Nicoll St., New Haven 4, Conn.

ROCKBESTOS A.V.C.

The Wire with Permanent Insulation

NEW YORK, BUFFALO, CLEVELAND, CHICAGO, PITTSBURGH, ST. LOUIS, LOS ANGELES, SAN FRANCISCO, SEATTLE, PORTLAND, ORE.

▲ The American Standards Association has just approved a revision of the American Standards for Lightning Arresters, first approved in 1936. These apply to substantially all the arresters designed for the protection of alternating current power circuits.

Each year millions of dollars and man-hours are lost through the breakdown of expensive equipment when lightning, striking on or near an electric power line, causes a sudden jump in electric voltage. When there is a sudden attack of alien voltage, the lightning arrester diverts the unusually high voltage to the ground, and returns the circuit again to its original condition. Hence the protection afforded by these arresters is an important weapon against fires.

The American Standards for Lightning Arresters (C62.1-1944) for alternate-current power circuits, may be obtained for 30 cents a copy from the American Standards Association, 29 West 39th Street, New York 18, New York.

Review copy available on request.

▲ Bulletin No. 28-A illustrates and describes a modernized, streamlined thermal oiler with plastic reinforced reservoir that automatically supplies the proper amount of oil for solid, wick and waste packed bearings where only a small amount of oil is required. It drops oil automatically when bearing heats and stops feeding when bearing cools. Oil supply is always visible, eliminating the guesswork of hand-oiling.

The bottle oiler style has a vibrating rod which, on the slightest vibration or vertical movement, releases oil to the bearing. Available in two and four ounce capacities. Write for your free copy. Trico Fuse Mfg. Company, 2948 North 5th Street, Milwaukee 12, Wisconsin.

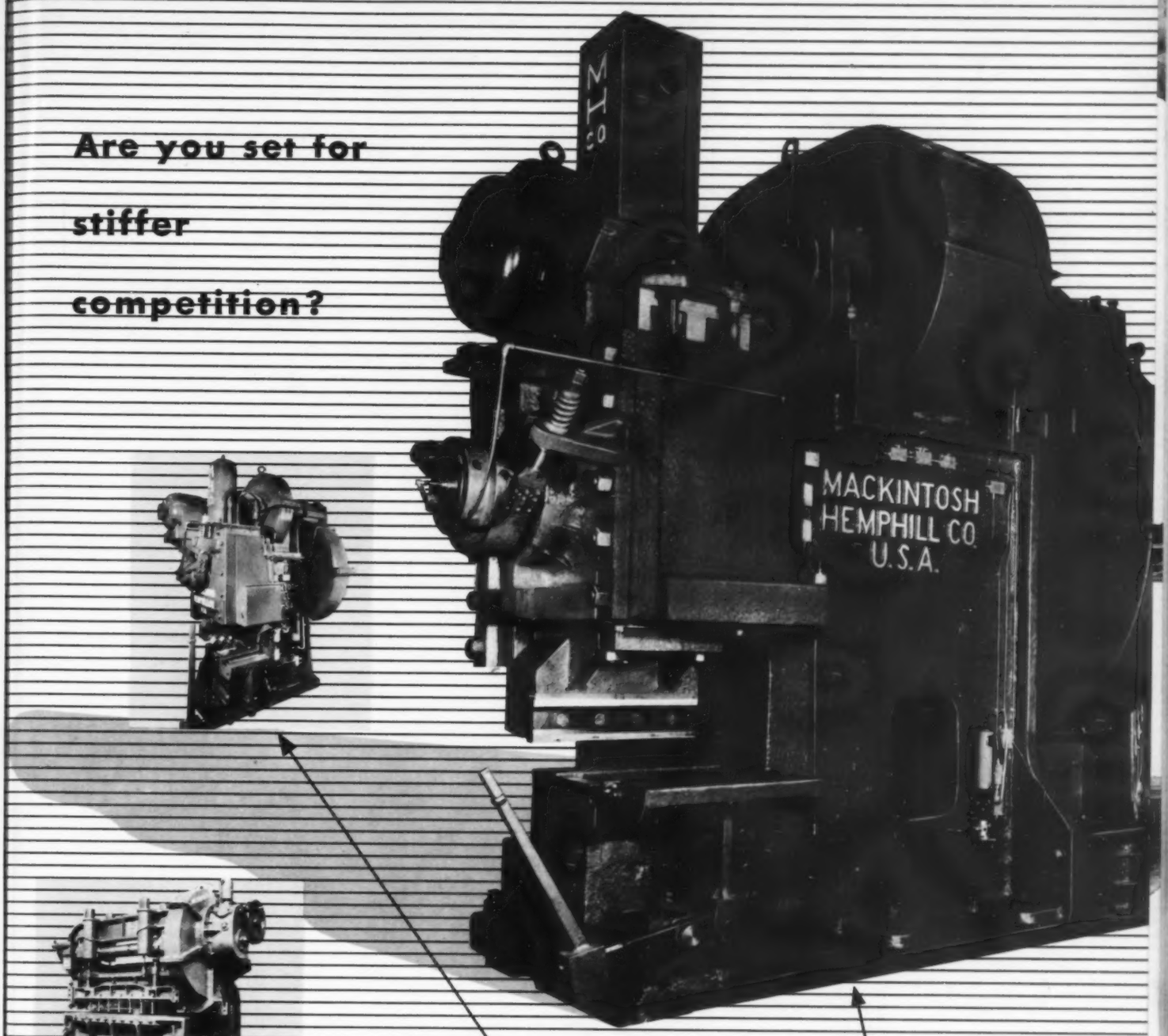
▲ A technical bulletin No. WTH-44 containing descriptions, applications, specifications, and features of the new improved line of Weltronic "package unit" heat controls, which provide dial-controlled, infinitely variable phase-shift regulation of welding current, has been released by Weltronic Company, 19500 West Eight Mile Road, Detroit 19, Michigan.

Models are now available for virtually every resistance-welding process including spot, seam, pulsation, butt, flash, and forge welding, etc. Models for dual and triple heat controls are essentially combinations of the standard models and provide accurate pre-selective current adjustment for two or more welding operations performed with the same machine or gun.

Detailed specifications are given together with photographs of various models.

▲ A four-page bulletin describing and illustrating several types of hydraulic gauges has just been issued by the Watson-Stillman Company of Roselle, New Jersey. This publication covers the company's direct stem and flush mounted gauges for use on hydraulic presses and pumps where accurate, trouble-free indication of hydraulic pressures is essential. Known as Bulletin 230-A it gives specifications and construction in detail. Copies will be sent if requested on company letterhead, and addressed to the Watson-Stillman Company, Roselle, New Jersey.

Are you set for stiffer competition?



Model B1 Billet, Bar and Shape Shear (2¾" x 2¾" mild cold steel.)

Model B 6 - Billet, Bar and Shape Shear (7" x 7" mild cold steel.)

1" thick x 100" wide Plate Shear.

MACKINTOSH-HEMPHILL *modern* shear design means FASTER, CLEANER, MORE ECONOMICAL CUTS

Are your shearing costs too high? Mack-Hemp Shears have cut operating expenses in dozens of plants. They are the last word in economical, large volume production. They typify what M-H advanced engineering and plenty of "know how" manufacturing experience can accomplish. Available in six sizes of billet shears (up to 7" x 7" mild steel billets) and plate shears from ⅜" to 2" thick (up to 156" wide) they give you a definite advantage in meeting today's production schedule and tomorrow's market price . . . Write for details.

MACKINTOSH-HEMPHILL CO., Pittsburgh and Midland, Penna.

Makers of the Rolls with the Red Wobblers

OTHER PRODUCTS:—Rolling Machinery . . . Shape Straighteners . . . Strip Coilers . . . Shears . . . Levellers . . . Pinions . . . Special Equipment . . . Iron Steel Castings . . . The NEW Abramsen Straightener . . . Improved Hewitson Patented Corrugated Cinder Pots and Supports . . . Heavy Duty Engine Lathes.

EVERYONE RESPONSIBLE FOR EFFICIENT LUBRICATION OF MACHINERY SHOULD HAVE THESE

Free BULLETINS

Save

BEARINGS → MACHINE HOURS → MAN HOURS → POWER → and Prevent Accidents

I WOULD LIKE TO HAVE FREE BULLETINS

On Lincoln Centro-Matic Lubricating Systems.

Name _____

Title _____

Company _____

Address _____

City _____ *State* _____

ISE 144-11

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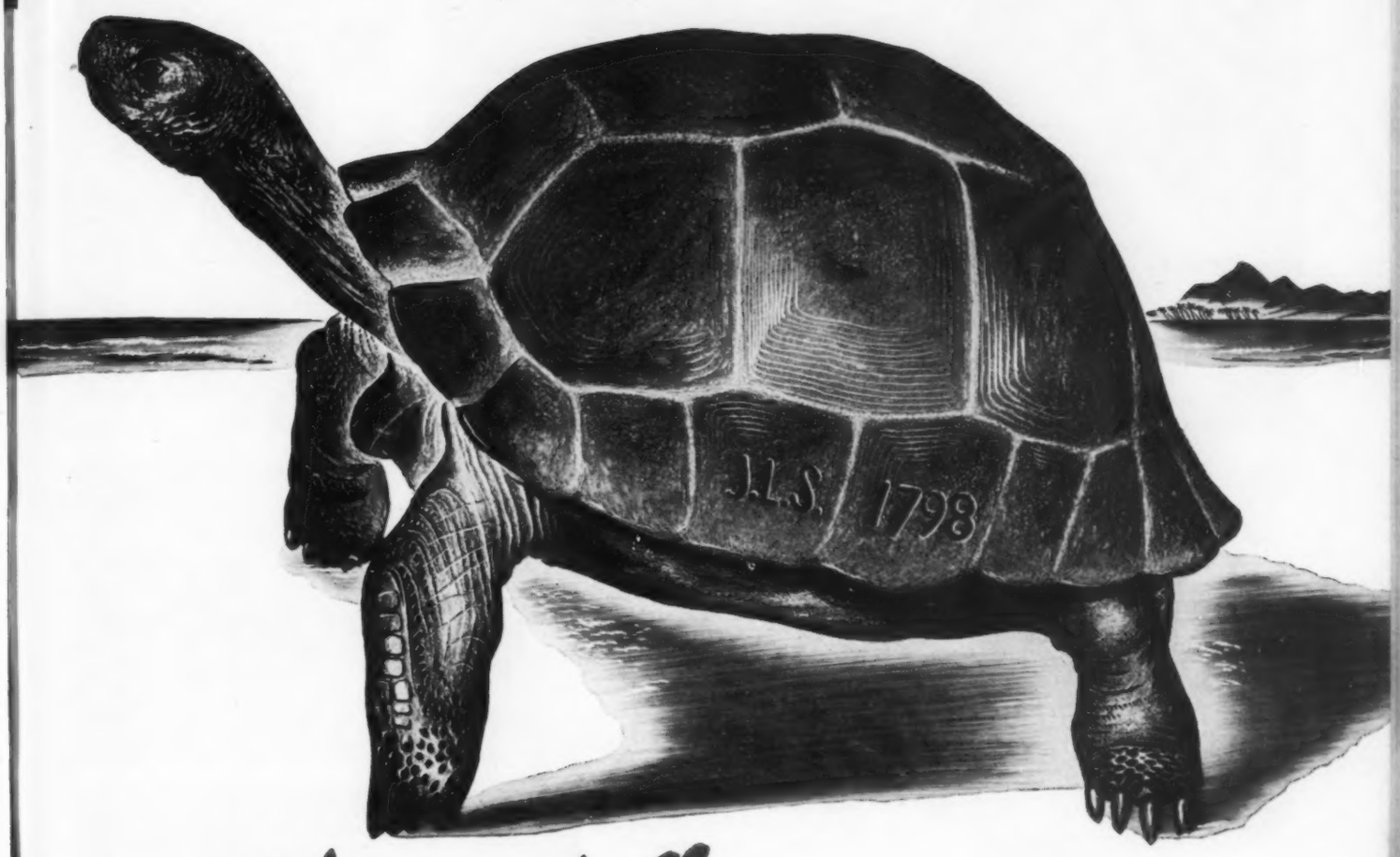
LINCOLN ENGINEERING COMPANY

Pioneer Builders of Engineered Lubricating Equipment

5701 NATURAL BRIDGE AVE., ST. LOUIS 20, MO., U. S. A.

"UNIVAN"

That Tough Steel



"Old Tuffy"

When whaling in the South Pacific was profitable many a harpooner left his card for future generations to find carved on the shell of an ageless tortoise.

"Old Tuffy" and his many relatives reckon time, not in years, but centuries. And these rugged creatures have much in common with "UNIVAN"—that tough alloy steel we use in fabricastings which stand up under severe shocks and stresses with notable lack of fatigue for far longer than is expected.

If the design is intricate and the requirements rigid take advantage of Union's long experience in heat-treated castings of "UNIVAN"—*that tough steel.*

For Long Life with Economy Specify "UNIVAN" That Tough Steel

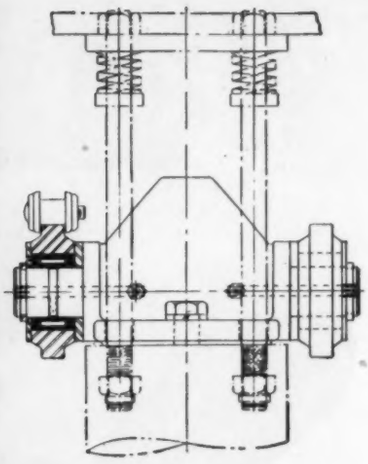
BUY MORE WAR BONDS AND STAMPS

UNION STEEL CASTINGS

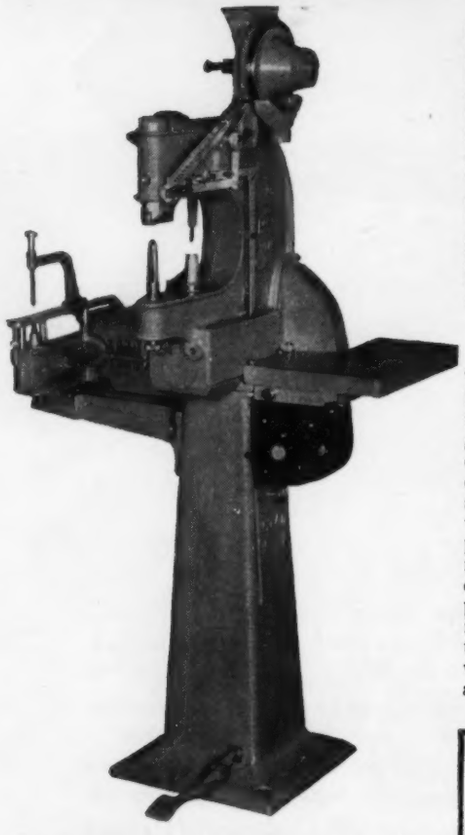
DIVISION OF BLAW-KNOX CO.
PITTSBURGH, PA.

MAKERS OF Driving Wheel Centers, Locomotive Frames, Pump Casings, Vault Doors and Frames, Annealing Boxes, Spindles, Coupling Boxes, Open Hearth Charging Boxes, Gear Blanks — and other Castings for Steel Mills and General Industry.

IN THE NEWS
WITH TORRINGTON BEARINGS

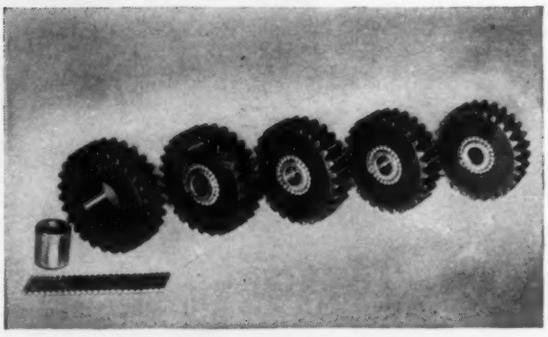


LIFT TRUCKS, manufactured by the Towmotor Corporation, are designed for the safe, rapid handling of multi-ton loads in around-the-clock service. To provide smooth operation in raising and lowering the load, Torrington NCS Needle Bearings are used on the hydraulic lifting cylinder crosshead. X-section clearly shows how compactness and high capacity of these bearings make them especially suitable for this interesting application.

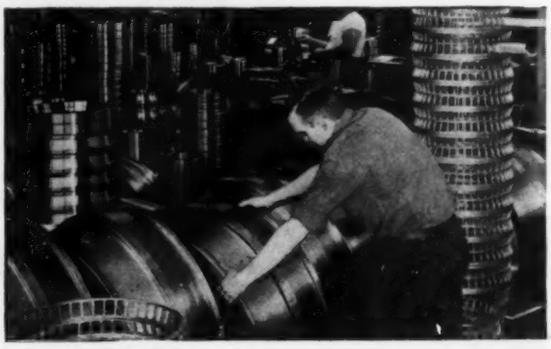


DELINING & RELINING of brakes is done rapidly and efficiently in a series of automatic operations performed by this brake relining machine manufactured by the Star Machine & Tool Company. Front and rear plungers, which perform the delining and riveting operations, operate at nearly 300 R.P.M. To reduce friction to a minimum, special Torrington Roller Bearings are used for the plunger rollers.

MORE THAN 150,000 Jahco airplane starters have been manufactured by the "associates" of Jack & Heintz, Inc. Noted for their dependability and instant response to the starter switch, Jahco starters are now used exclusively in all large combat and bombing aircraft. Due to the necessity for compact design and light weight, Torrington LN Needle Bearings were selected for use in the gears shown at the right.



"OUT OF THE ORDINARY" bearing applications are an important phase of Torrington's Engineering Service. The specifications may call for a bearing of unusual size, or special design. Frequently a bearing previously engineered for one application can be adapted to meet the requirements of another. Man in foreground in photo at right is handling the inner race of a large double-row tapered roller bearing, a type widely used in heavy-duty mill applications.



ARMY E NAVY

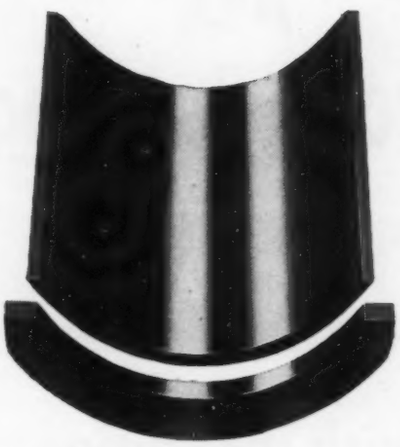
TORRINGTON BEARINGS

STRAIGHT ROLLER · TAPERED ROLLER · NEEDLE · BALL

THE TORRINGTON COMPANY · BANTAM BEARINGS DIVISION

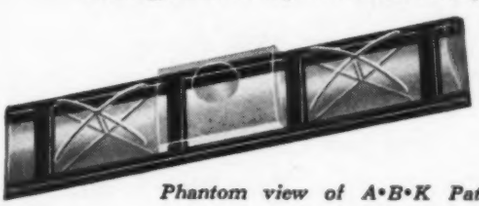
SOUTH BEND 21, INDIANA

A·B·K
Laminated Plastic Bearings
improve production records



A·B·K Roll Neck Bearing with separate collar.

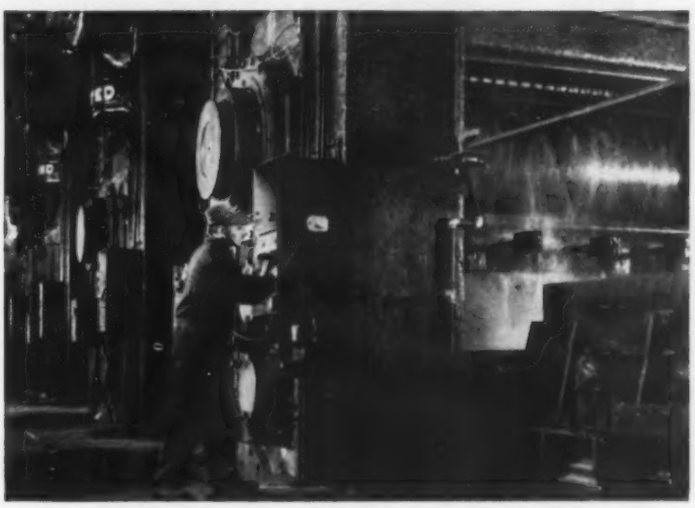
A·B·K Patented Reinforced Edge Slipper Bearing, made in required sizes to blueprints.



Phantom view of A·B·K Patented Reinforced Edge Slipper Bearing.

Industrial and Marine Uses
A·B·K Laminated Plastics

- Steel Mills
- Textile Mills
- Rubber Mills
- Paper Mills
- Industrial Truck Wheels
- Marine Stern Tube Bearings
- Pintle Bearings
- Rudder Bearings
- Pump Valve Discs
- Safety Tile and Tread



WITH production stepped up to new peaks, with heavy duty equipment rolling for longer periods without shutdown, A·B·K plastic bearings have proven superior to other type bearings.

In addition, A·B·K plastic bearings have established new records in many industrial plants for . . .

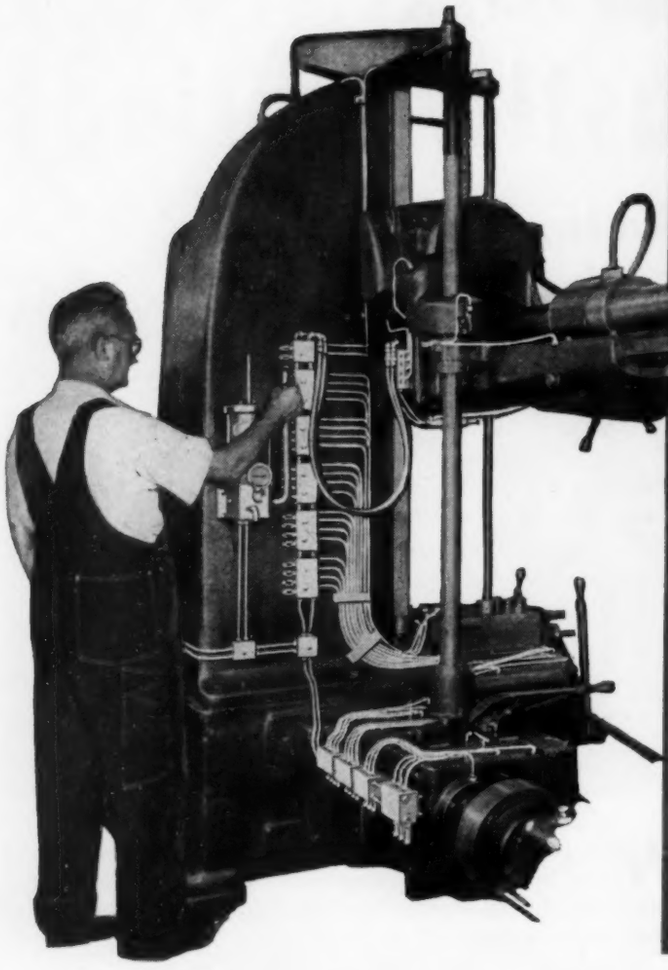
Lowering power consumption.
Lengthening bearing life.
Non-scoring of Roll Necks.
Eliminating lost time due to shutdown for bearing replacement.

A·B·K plastic bearings developed by American Brakeblok research engineers are made to tested formulae to fit the particular job for which they are intended.

The research and engineering facilities of A·B·K, designers of these improved laminated plastics, are available without charge for help in solving *your* bearing problems. Write American Brakeblok Division of American Brake Shoe Company, 4600 Merritt Avenue, Detroit 9, Michigan.

American Brakeblok
TRADE MARK REG. U.S. PAT. OFF.

DIVISION OF AMERICAN Brake Shoe COMPANY



HOW TO LUBRICATE ALL OF YOUR BEARINGS *at once*

with machines in full operation

THE Farval Centralized System of Lubrication puts your machines on a non-stop schedule: brings production up to high-profit levels and *keeps* it there. Farval lubricates every single bearing, no matter where it is, with the equipment running at full speed.

Your machines produce *more,* earn *faster*—because Farval eliminates the down time required to lubricate by hand or to repair the lack of lubrication. Bearings last from 5 to 25 times longer and consumption of lubricant is cut by 75%. *Farval savings add up fast!*

Farval will keep *your* Cranes, Shears, Mills, Tables, Ore Bridges, Furnaces, Levellers and other equipment on the job. Send for the nearby Farval Representative today. The Farval Corporation, 3278 E. 80th St., Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing
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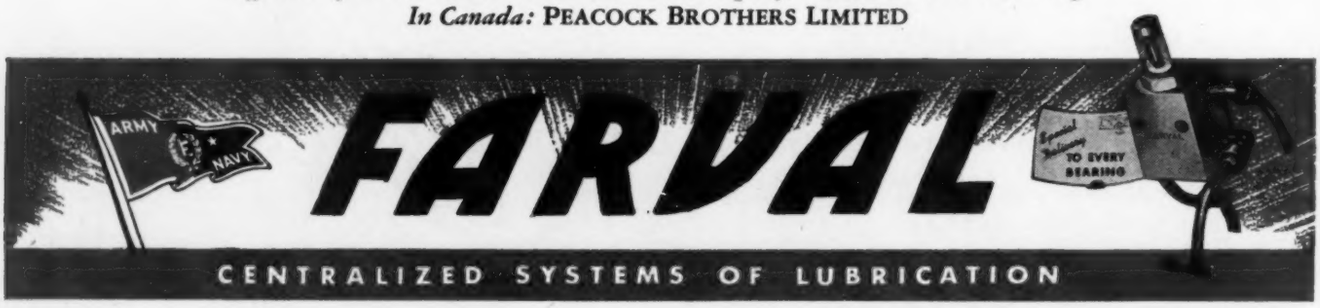

Personnel News

William A. Anderson is appointed assistant to general superintendent in Carnegie-Illinois Steel Corporation's Youngstown (Ohio) district, this U. S. Steel subsidiary has announced. He was Pittsburgh district industrial engineer of Carnegie-Illinois.

Mr. Anderson began his service with the company immediately after receiving his bachelor of science degree from Carnegie Institute of Technology in 1930, heing first employed as assistant specialty engineer at Carnegie-Illinois' Homestead Works, Munhall, Pennsylvania. In 1932 he entered the company's Pittsburgh general office as junior industrial engineer, returning to Homestead a year later as resident industrial engineer. He was transferred back to Pittsburgh in a similar capacity in 1935, and a month later assumed the position of district industrial engineer, which he held until his current appointment.

M. J. Boho has been appointed assistant general manager of sales, Hagan Corporation of Pittsburgh, suppliers of industrial automatic combustion control equipment. Effective immediately, Mr. Boho will assist **D. J. Erikson,** vice president in charge of sales.

Before joining the Hagan Corporation in 1936 as a sales engineer, Mr. Boho had been two years with Bailey Meter Company and three years with the Potomac Electric Company, Washington, District of Columbia. Mr. Boho is a graduate of the engineering college of Lafayette University, a member of the Engineers' Society of Western Pennsylvania and the Association of Iron and Steel Engineers. He is the author of several papers dealing with technical problems in industrial combustion control.

Frederick W. Mesinger has been elected a vice-president of Norma-Hoffman Bearings Corporation, succeeding **H. J. Ritter** who recently resigned. Mr. Mesinger takes up his new duties after some 24 years' connection with the firm's engineering staff, and for the past 16 years has been district manager of the New York office.

Carl Christiansen has been appointed to the Engineering staff of the John C. Dolph Company, Newark, New Jersey. He was formerly in charge of electrical construction for the Pan American Airways in the South Pacific. Previous to this, he was associated with Curtiss-Wright Corporation—Electrical Division, and International Motor Company.

George F. Paul has become associated with National Steel Company of Brazil as superintendent of flat rolling. In this capacity he will have charge of plate, hot and cold strip and tinplate production at the company's new plant at Volta Redonda, Brazil. Mr. Paul was formerly connected with Inland Steel Company and Youngstown Sheet and Tube Company, in the erection and operation of their continuous strip mills. In 1938, he went with John Summers and Sons, Ltd., Shotten, Chester, England, as manager of hot and cold strip mills, returning to the United States early this year. Mr. Paul has already gone to Brazil to assist in the erection of the mills.

Paul W. Coffman has been made flat rolled engineer for National Steel Company of Brazil. Mr. Coffman began his steel plant work at Bethlehem Steel Company, Sparrows Point, Maryland, and in 1938 went to England where he helped start and operated the cold reduction mill at Richard Thomas & Company, Ltd. at Ebbw Vale, Monmouthshire. In 1939 he joined John Summers and Sons, Ltd., aiding in the erection and later supervising the operation of the cold strip mill. Mr. Coffman returned to the United States early this year, when he became connected with Mesta Machine Company

M. J. BOHO

GEORGE F. PAUL

PAUL W. COFFMAN

ROWAN
Oil Immersed
MOTOR CONTROL
OK
BY USERS EVERYWHERE
ROWAN CONTROL
THE ROWAN CONTROLLER CO., BALTIMORE, MD.

ELECTRIC
DOOR LIFTS
Conveyor and Car Puller Drives
DOOR LIFTS FOR
Furnaces · Ovens · Industrial Buildings
DRIVES AND PULLERS FOR
Furnaces · Ovens · Cars · Mixers
NEW PRINCIPLES OF DESIGN
Low in Cost · High in Efficiency
SEND FOR CATALOG
FRED J. RYAN COMPANY
WYNCOTE, PENNA., U.S.A.

Donald W. McGill has been appointed manager of the machinery electrification section of the industrial department, Westinghouse Electric and Manufacturing Company.

The new appointee succeeds **L. F. A. Mitchell,** who has returned to the Canadian Westinghouse Company as assistant to the vice president. Mr. McGill, formerly a staff member of the machinery electrification section, will be in charge of company application of electrical equipment and controls for industrial machinery.

A native of Dawson, Pennsylvania, the new manager came to Westinghouse in 1933 as a member of the graduate training course. He entered the industrial department in 1935 and was attached to the steel mill and metal working section, handling steel mill auxiliaries, automotive industry, heat treating, welding and aluminum companies and induction heating activities.

Mr. McGill was transferred to the machinery electrification section in January, 1943, where he handled contacts with the machine tool industry. He has headed the annual Westinghouse Machine Tool Electrification Forum for the past two years.

He attended Penn State College where he received his bachelor of science degree in electrical engineering in 1932.

C. J. Chapman, sales engineer in the carbon products division, National Carbon Company, Pittsburgh, Pennsylvania, has been appointed assistant manager of the southern division of that company, with headquarters in Atlanta, Georgia. Following graduation in engineering from Dartmouth College, Mr. Chapman was employed by International Business Machines Corporation and in 1935 joined National Carbon Company in their Buffalo office. In 1937 he was transferred to Pittsburgh.

T. R. Mumford has been made sales engineer in the Pittsburgh district, carbon products division, National Carbon Company. Mr. Mumford attended Tufts College and spent eight years with Worthington Pump and Machinery Corporation. In 1938 he joined National Carbon Company in the Philadelphia office and in 1942 was transferred to Birmingham, Alabama.

Ivor Bryn has been appointed vice-president in charge of manufacturing by the McLouth Steel Corporation, Detroit. He has been general superintendent

BEARING BOTTLENECKS ELIMINATED
GATKE Moulded Fabric Bearings have proved that delays can be avoided and costly machine shop work eliminated.
From the largest, to the smallest roll necks, table rolls, Universal Couplings, Cranes and other tough service—GATKE Bearings are effecting improvements that are so tremendous they must be experienced for full appreciation.
Particulars on request.
GATKE CORPORATION - 228 N. La Salle - CHICAGO

since the incorporation of the company ten years ago, and previously was with the Otis Steel Company for many years in mill operating capacities.

J. J. MELLON

James J. Mellon has been elected president of the Clark Controller Company, succeeding Primus P. C. Clark, recently deceased founder of the company.

Mr. Mellon was graduated from Rensselaer Polytechnic Institute with an electrical engineering degree and for 15 years was assistant sales manager of the company, more recently serving as vice president. He has spent his entire business career in the heavy duty electrical control field. He is a member of the Association of Iron and Steel Engineers, is active in N. E. M. A., and is well known in the electrical control industry.

W. H. WILLIAMS

W. H. Williams, former vice president in charge of sales for Clark Controller Company, was elected executive vice president and general manager, a newly created position designed to divide duties more equitably. Mr. Williams is also a veteran in the electrical control industry, and was a co-founder with Mr. Clark in establishing the company. He is a graduate of Drexel Institute with a degree in electrical engineering. His wide acquaintance in the industry and his knowledge of the electrical control business particularly fit him for his new duties. He is a member of the Association of Iron and Steel Engineers, and is also active in N. E. M. A. affairs.

SAFETY STEEL
HEAVY BEVEL
WILL NOT SPALL! WILL NOT MUSHROOM!
LETTERS and FIGURES

Cunningham Safety Heavy Bevel Letters and Figures are adaptable to practically any metal marking including armor plate and other tough materials.

Built for hard, continuous use and long life. Available in any character from 1/32" up.

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SAFETY STEEL STAMPS
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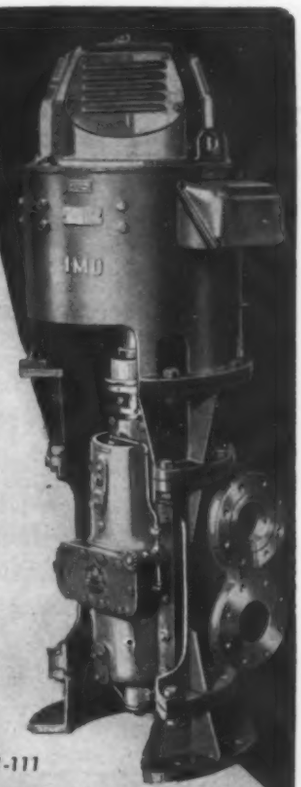
The MOST PUMP in least Weight & Space



The DeLaval-IMO pump for fuel oil and "lube" oil services is distinguished by compactness and simplicity. There are only three working parts, which are in complete hydraulic and rotational balance and which propel the oil without pulsation, like a piston moving steadily forward. There are no valves, no gears, no cams and no reciprocating parts. The one packing is under suction pressure only and is easily accessible. Any quantity of oil is delivered against any pressure.

Ask for Publication I-111

IMO PUMP DIVISION
of the De Laval Steam Turbine Company, Trenton, N. J.

NEW YODER RESISTANCE WELD PIPE MILL-

Tapered Roller TIMKEN BEARING EQUIPPED

Capacity—1½" to 6" diameter standard pipe.
Production rate—1½" standard pipe—about 80 F. P. M. 6" standard pipe — about 65 F. P. M.
Total speed range — 30 to 90 F. P. M.
Total overall floor space—278' 0" long x 36' 0" wide.

Completely TIMKEN BEARING EQUIPPED

The Yoder Company, Cleveland, Ohio recently designed and built a 1½"-6" capacity resistance weld pipe mill.

Before being shipped, the mill was set up in the manufacturer's plant for testing and inspection; the photographs reproduced here were made at that time.

This piece of equipment has attracted a lot of attention and received a great deal of commendation for its excellence of design and performance.

Prominent among the modern features responsible for speed and precision are Timken Tapered Roller Bearings, which are used throughout the mill on all rolls and at other important positions.

Timken Bearings were chosen on the basis of their suitability for the job and also on the strength of the mill builder's long experience with them. Yoder knows it pays — and so do users of Yoder equipment. The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

Howard C. Herbert has joined Allis-Chalmers Manufacturing Company as a field engineer to handle primarily steel mill customers in the Pittsburgh district

Mr. Herbert has worked in the engineering departments of the Carnegie-Illinois Steel Corporation and the Gulf Refining Company and of recent years has been a Pittsburgh representative of the I-T-E Circuit Breaker Company.

HOWARD C. HERBERT

Roscoe H. Smith, who has been manager of applied engineering for the Reliance Electric and Engineering Company has been named head of the company's sales promotion department, assisted by **Kenneth F. Ertell,** who has been named assistant advertising manager. Under the enlarged set-up ,**C. V. Putnam** relinquishes his duties as advertising manager to Mr. Smith but will continue his executive responsibilities as secretary of the company.

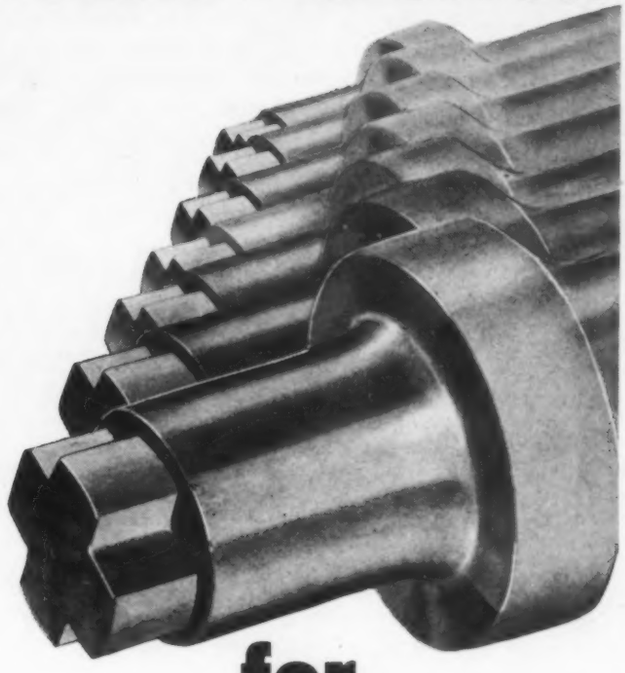
Mr. Smith attended the U. S. Naval Academy and the Massachusetts Institute of Technology. He graduated from the latter in 1923 with a degree of B.S. in Electrochemical Engineering, and immediately joined Reliance in Cleveland. Subsequently he was assigned to sales offices in Chicago and in Boston, returning to Cleveland early in 1932 to devote all of his time to application engineering for the company.

Richard A. Geuder, who has been manager of metal industry applications, Reliance Electric and Engineering Company, will assume Mr. Smith's previous responsibilities as manager of applied engineering, without, however, abandoning altogether his specialization in motor drive problems of the metal industry. He will be assisted by **John L. Van Nort,** until recently sales and application engineer for Reliance in Salt Lake City, and **William C. Madsen,** who has been on the company's application engineering staff for the past three years.

Mr. Geuder obtained his B.S. in Electrochemical Engineering from Pennsylvania State College in 1929 and has been engaged in application engineering work for Reliance since that time.

K. R. Van Tassel has been named manager of the industrial control division of General Electric's industrial

FREEDOM FROM FRICTION



for ROLL NECKS

LESSEN power losses; reduce friction with DIXON'S GRAPHITE ROLL NECK GREASES. A special made-for-the-purpose lubricant, Dixon's prevents undue scoring of necks and brasses . . . lessens wear at bearing points.

Especially valuable for mills with plain bearings, Dixon's meets every requirement of complete lubrication. Dixon's . . . saves power . . . reduces labor maintenance . . . and eliminates cost of frequent renewals. Write for RN-18.

JOSEPH DIXON CRUCIBLE COMPANY, JERSEY CITY 3, N. J.

Canada: Canadian Asbestos Company • Montreal • Vancouver • Toronto • Winnipeg

Microfyne Graphite • Pipe Joint Compound • Graphite Seal • Graphited Oils
Waterproof Graphited Grease • Gear Lubricants • Graph-Air Guns
Cup and Pressure Gun Grease • Auto-Marine Grease • SlipStik
Lathe Center Graphite Lubricant • Belt Dressing (Contains no Graphite)

divisions. Mr. Van Tassel succeeds **George R. Prout,** recently appointed manager of the company's air conditioning and refrigeration division of the appliance and merchandise department.

Mr. Van Tassel, a native of Geneva, New York, attended Hobart College and was graduated from the Massachusetts Institute of Technology in 1925. He joined the General Electric Company as a student engineer the same year. In 1926, he was transferred to the transformer engineering department, Pittsfield, Massachusetts, where he remained until 1928 when he entered the single-phase motor department there. Later he was made designing engineer of that department.

In 1932, he was transferred to the fractional-horsepower motor engineering department, Fort Wayne, Indiana, in 1936 becoming its commercial engineer and in 1938 staff assistant to the manager of the Fort Wayne Works. In June, 1940, Mr. Van Tassel was made manager of sales of Lynn motors, at General Electric's Lynn works, where he remained until October, 1942, when he was named sales manager of the integral-horsepower motor section of the motor division, with headquarters at Schenectady.

Obituaries

Primus C. Clark, president of the Clark Controller Company, died July 8th after an illness of one week.

Mr. Clark organized the Clark Controller Company in 1925 and, as its president, watched it grow from a

PRIMUS C. CLARK

mere handful of employees to a force of more than 1,000 with branches from coast to coast.

Born in Lafayette, Indiana, in 1873, Mr. Clark attended the public schools there and was graduated from Purdue University. His first work was with the New York Central Railroad there.

He came to Cleveland to work in the New York Central offices here, but he soon left to enter the electrical department of the Wellman, Seaver, Morgan Company. This department was expanded into the Electric Controller and Manufacturing Company, with Mr. Clark as vice-president and treasurer. He left to organize his own company.

Mr. Clark was particularly proud that his company was among the early plants to obtain the award of the Navy "E", with added stars since for continued excellence in production. He often cited, also, the fact that, of the original handful of employees, all but one of the officers still was with the company. Mr. Clark was a member of the Association of Iron and Steel Engineers.

Lieutenant Laddie J. Zindar was killed in action over Germany on May 28th. He was previously reported missing in action on that date. Lieutenant Zindar attended Case School of Applied Science. Upon graduation in 1936 he entered the employ of Cutler-Hammer, Inc., Milwaukee, Wisconsin, where he received engineering and sales training preliminary to joining the company's Detroit office in 1937. Enlisting in the Air Force in November, 1942, he received his training at Selman Field, Louisiana, and was sent to England in April, where he served as navigator in a Flying Fortress crew.

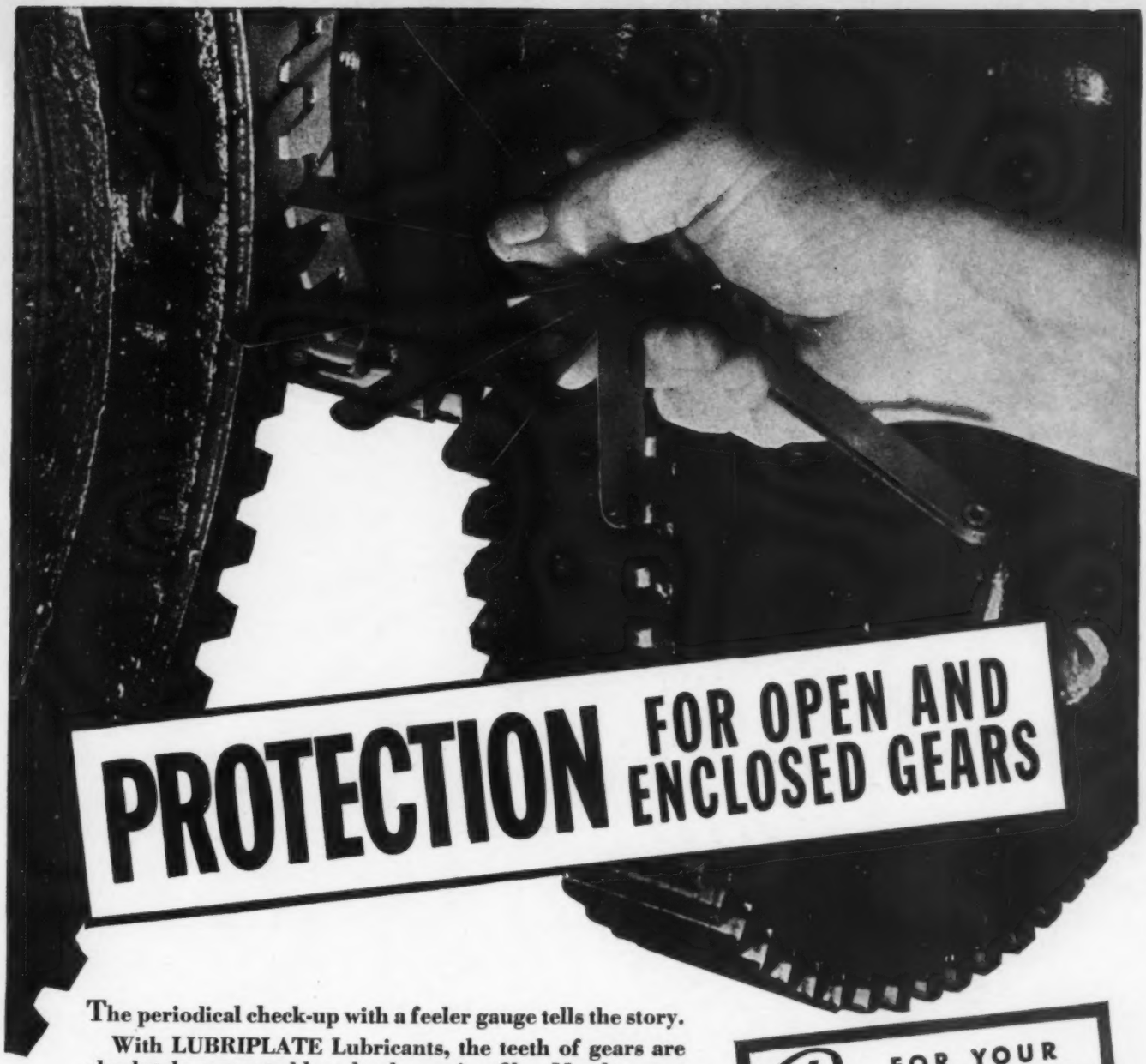
Frank B. Thompson died July 2nd at his home in Beaver, Pennsylvania. Mr. Thompson had retired as vice president of American Bridge Company, United States Steel Corporation subsidiary, on July 1, 1936.

Mr. Thompson began his business career in the steel industry in 1886 as a clerk in the general offices of Carnegie Steel Company. He became auditor of American Bridge Company in 1905 and was appointed vice president in 1927. He was also auditor of Canadian Bridge Company, another United States Steel subsidiary.

Specialists for over a generation in

OIL IMMERSED MOTOR CONTROL

ROWAN CONTROL
THE ROWAN CONTROLLER CO., BALTIMORE, MD.



PROTECTION FOR OPEN AND ENCLOSED GEARS

The periodical check-up with a feeler gauge tells the story.

With LUBRIPLATE Lubricants, the teeth of gears are absolutely separated by a load carrying film. Metal cannot touch metal. LUBRIPLATE lowers operating temperatures and seals the gears against rust and corrosion. Yet, in spite of its protective qualities, LUBRIPLATE does not cause drag. Even the most delicate, high speed gears operate better with it. LUBRIPLATE reduces friction to a minimum.

Yes, open and enclosed gears as well as chains, slides, sleeve and anti-friction bearings and all contacting parts last longer and require less power to drive them when lubricated with LUBRIPLATE. Let us send you a copy of "The LUBRIPLATE Film" that tells the whole story. It is written especially for your industry.

Rx FOR YOUR MACHINERY

No. 3—Ideal for general oil type lubrication. Ring oiled bearings, wick feeds, sight feeds and bottle oilers.

No. 6—Because of its high film strength and long life reflects outstanding performance in most types of enclosed gears (speed reducers).

No. 107—One of the most popular grease type products for general application by pressure gun or cups.

No. 70—For a wide range of grease applications, especially at temperatures above 200 degrees F.

No. 130-AA—Known nationwide as the superior lubricant for open gears, heavy duty bearings, wire rope, etc.

BALL BEARING—This is the LUBRIPLATE lubricant that has achieved wide acclaim for use in the general run of ball and roller bearings operating at speeds to 5000 RPM and temperatures up to 300 degrees F.

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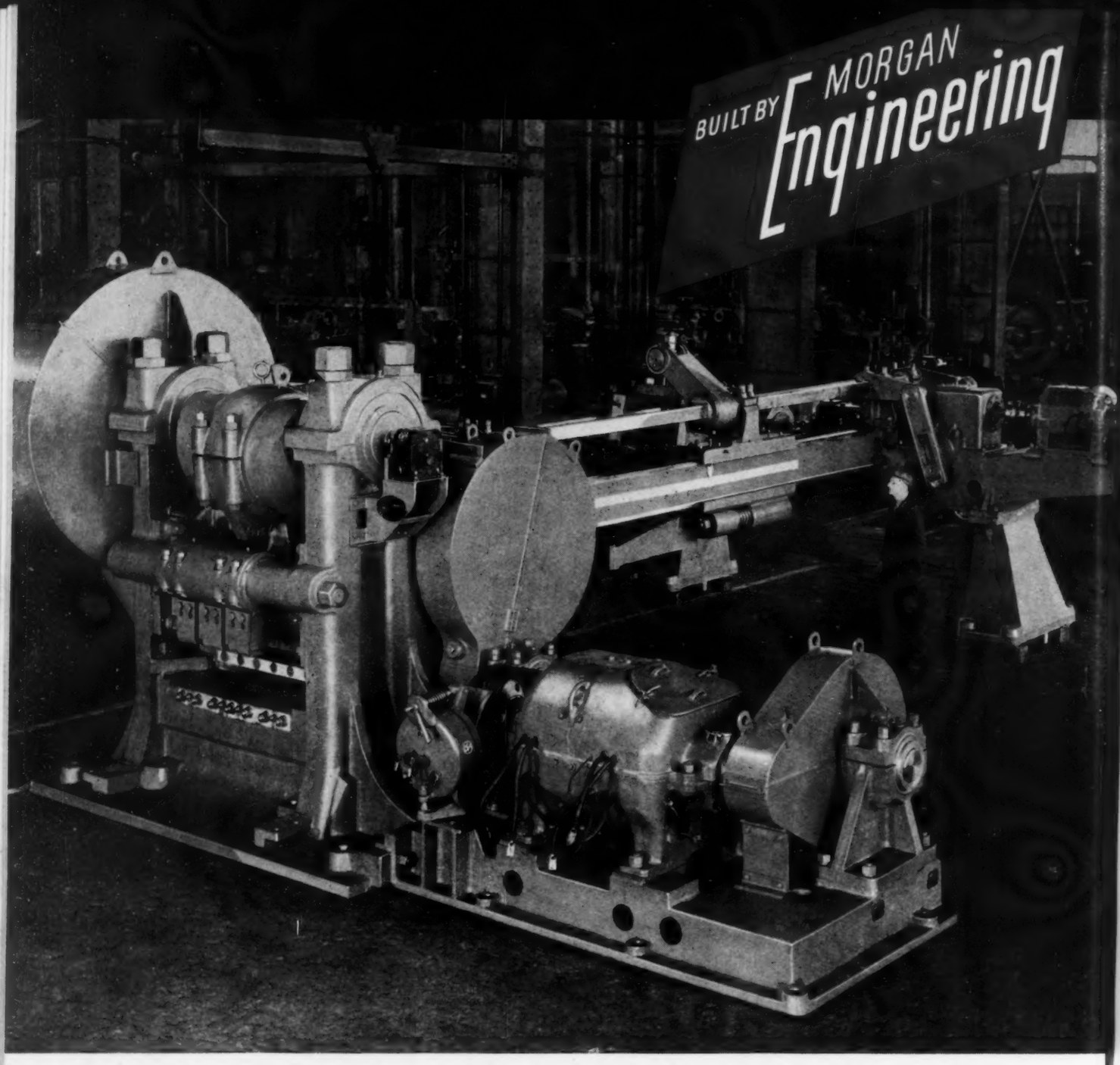
WRITE FOR THE NAME OF THE DEALER NEAR YOU



MORGAN 450-TON BLOOM AND SLAB SHEAR

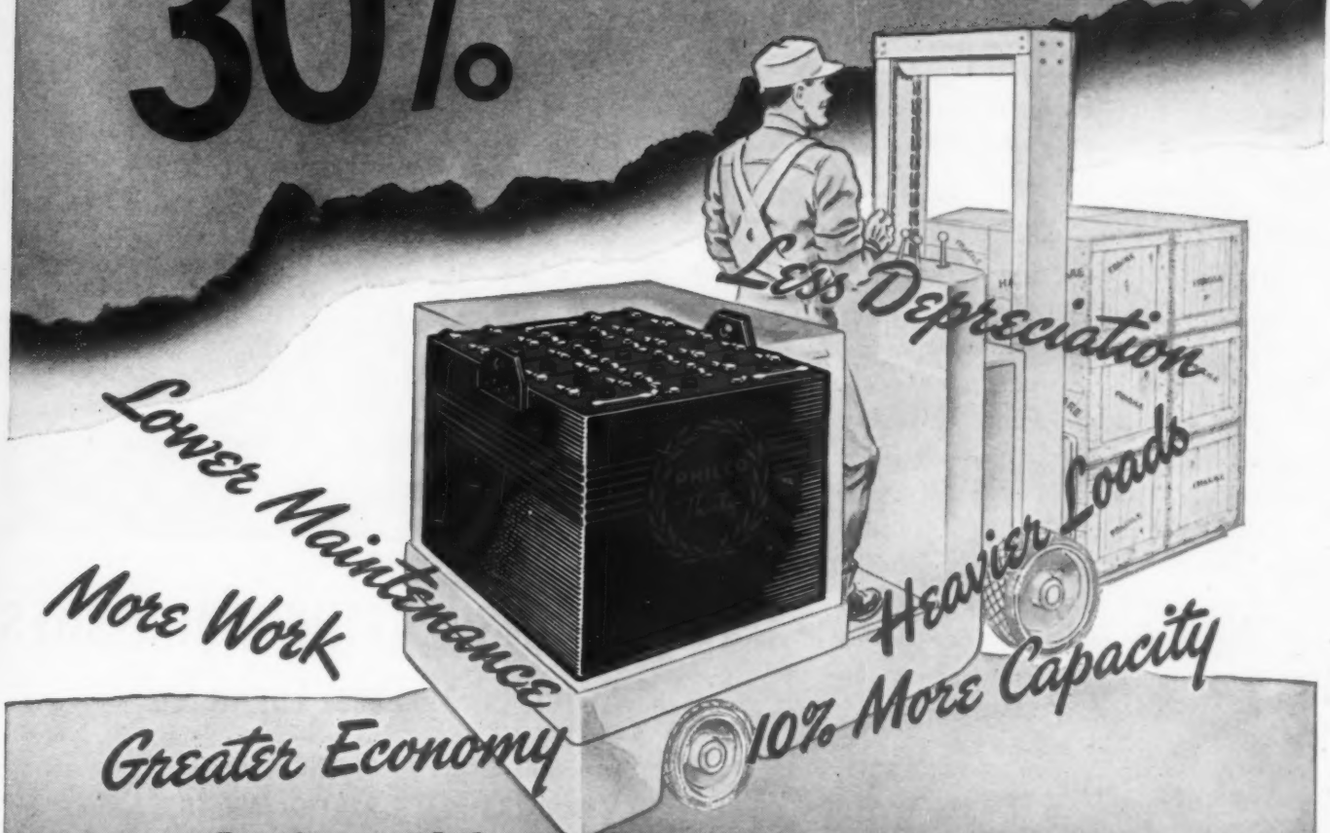
● Among the many types of mill equipment built by Morgan, is the 450-Ton Bloom Shear illustrated above for shearing 12″ x 12″ blooms and equivalent slab sections. Shear is designed without flywheel or clutch for start and stop operation. Hold-down gag is of the independent hand adjusted type. A motor operated gauge is provided for gauging lengths from 2′0″ to 15′0″. Of massive construction, this shear is typical of the types of mill equipment Morgan designs and builds.

THE MORGAN ENGINEERING CO.
ALLIANCE, OHIO. 1420 Oliver Building, Pittsburgh

DESIGNERS • MANUFACTURERS • CONTRACTORS • BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS • ELECTRIC TRAVELING CRANES • CHARGING MACHINES • INGOT STRIPPING MACHINES • SOAKING PIT CRANES • ELECTRIC WELDED FABRICATION • LADLE CRANES • STEAM HAMMERS • STEAM HYDRAULIC FORGING PRESSES • SPECIAL MACHINERY FOR STEEL MILLS

Just Announced!

REVOLUTIONARY NEW "PHILCO THIRTY" GIVES 30% LONGER LIFE!



Again . . . Philco Makes Engineering History

At last, a motive power battery with a revolutionary, new construction that actually gives you *30% longer life . . . and more!* A brand new principle of fabricated insulation . . . developed after years of research in the Philco laboratories, and now introduced after exhaustive tests in actual service. It's the *Philco "Thirty"* . . . your post-war battery, available now in certain types and limited quantities. Write today for full information.

PHILCO CORPORATION, *Storage Battery Division, Trenton 7, New Jersey*

FOR 50 YEARS A LEADER IN INDUSTRIAL STORAGE BATTERY DEVELOPMENT

In the Steel Industry where heat is a factor

For over a third of a century electrical engineers in the steel industry have continued to specify DOLPH'S Insulating Varnishes for the maintenance of electrical motors, generators and transformers. The reason is simply this — These insulating varnishes are time proven and tested and their quality and performance well established.

In the DOLPH Line there are insulating varnishes formulated for maintenance work. Some of the baking grades are excellent for large armature and stator coils which are treated in varnish prior to their insertion in the slots. Because of the high degree of flexibility which these varnishes possess, the coils may be stretched into the slots without rupturing the insulation. There are also other insulating varnishes of the air drying variety which were designed to provide extra protection to windings, commutator ends, string bands, etc. of units operating under severe conditions.

If you are not familiar with DOLPH'S Insulating Varnishes, why not write today and let us outline a maintenance program which will provide high efficiency of your electrical equipment.

DOLPH'S INSULATING VARNISHES

Specified by Steel Engineers

CHINALAK CLEAR BAKING VARNISH
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JOHN C. DOLPH COMPANY

Insulating Varnish Specialists

166A EMMETT ST. NEWARK, N. J.

Just in case you've eased up... ON YOUR PAY ROLL PLAN

Pause one brief moment. Compare your lot—and that of the men and women in your employ—with the lot of the infantrymen who meet the enemy face to face, who do the hardest fighting, who suffer the most casualties.

Let the full impact of war's unending grimness swiftly convert any tendency toward complacency into revitalized urgency. Remember—the war is not yet won.

As top management and labor, you've been entrusted with two major responsibilities—steadily maintained production, and steadily maintained War Bond Sales *through your Pay Roll Savings Plan.*

Decide *now* to revitalize your plant's Pay Roll Plan. Have your Bond Committee recheck all employee lists for percentages of participation and individual deductions. Have Team Captains personally contact each old *and new* employee. Raise all percentage figures wherever possible.

Don't underestimate the importance of this task. This marginal group represents *a potential sales increase of 25% to 30% on all Pay Roll Plans!*

Your success will be twofold: A new high in War Bond Sales; and a new high in production. Because a worker with a systematic savings plan has his mind on his work—not on post-war financial worries. He's taking care of the future now. His own. And his Country's future. *Help him!* REVITALIZE YOUR WAR BOND PAY ROLL SAVINGS PLAN.

Official U. S. Coast Guard Photo: The elevator to a Coast Guard-operated transport hospital

Back the Attack! SELL MORE THAN BEFORE!

The Treasury Department acknowledges with appreciation the publication of this message by

Iron and Steel Engineer

This is an official U. S. Treasury advertisement—prepared under the auspices of Treasury Department and War Advertising Council.

Adjustable-speed direct-current motors drawing one of a wide variety of wire products in a typical mid-western wire mill.

PRODUCTION SPEEDED

with added flexibility and safety...

This particular application of Reliance Motor-drive is in a wire-drawing mill. But the basic idea it emphasizes—*that motor-drive is MORE than power*—can be used in many ways, practically anywhere that motor-driven machinery is employed

Taking advantage of features inherent in the electric motor, the designers and users of wire-drawing machines have stepped up drawing speeds to double and triple those previously thought possible, and the new methods making use of Reliance Motor-drive are more flexible, better adapted to variations in production schedules and far safer.

Reliance men are always glad to place their specialized knowledge of electric motor-drive at the service of design or production engineers. This kind of teamwork frequently saves much planning and designing time and produces highly satisfactory results. Just write or phone the nearest Reliance office if you're interested.

RELIANCE ELECTRIC & ENGINEERING COMPANY
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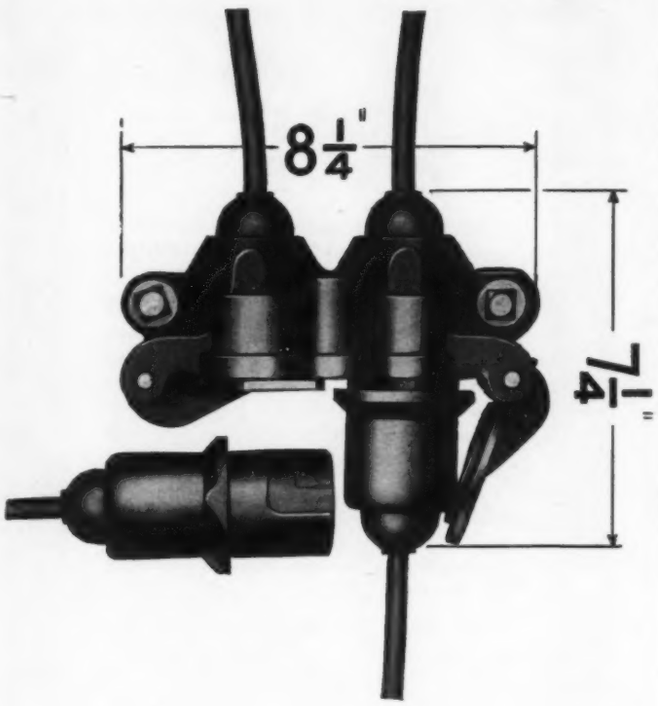
RELIANCE A·C D·C MOTORS

OHIO ARMORED
WEATHER PROOF
CONNECTORS



Save time to make or break connections.

They are operated by hand, (see the Bayonet Joint in Cut).

No Tools or Tape required.

No danger, live parts covered by insulated Iron Shell.

Two Pole Connectors have Automatic Spring Cover closing live end when not connected.

They also have support Ears for mounting (see cut).

Single Pole Connectors are furnished without Spring Closing Covers or Support Ears.

Cable Ends are No. 4 B & S Extra Flexible Insulated Wire.

Capacity 150 amperes continuous.

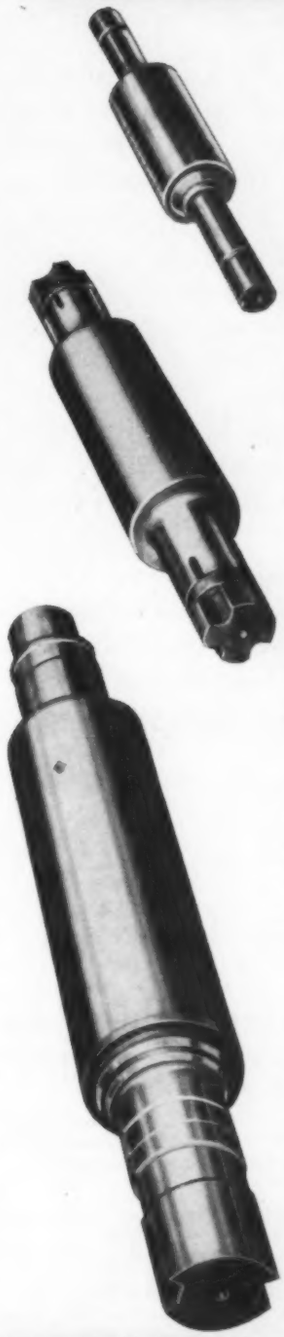
	Weight	Net Price
Single Pole Connectors	5 Lbs.	$12.00 Each
Double Pole Connectors	13½ Lbs.	$25.00 Each
Lower or Plug End Separately		$ 7.50 Each

Priority required — F. O. B. CLEVELAND

OHIO reliable MAGNETS

The OHIO Electric Mfg. Company
5907 Maurice Avenue
Cleveland, 4 · · Ohio

NATIONAL ROLLS



THE WORLD AS A MARKET

FOR years, Europe, after the war's devastation, will not be able to supply herself fully with materials and goods — particularly metals.

America will thus be a chief source of world supply.

Foreign tariff forces will be — MUST be — lowered to admit our products, of which iron and steel are leading essentials.

So post-war pessimism gives way with thinking people to reconstruction optimism, so far as American industry is concerned.

NATIONAL ROLLS are representative of the great metallurgical advance in all roll-making, and are ready to serve, with other good rolls, as key implements in producing the anticipated post-war record output.

The NATIONAL ROLL & FOUNDRY COMPANY
All Grades of Cast Rolls—Iron and Iron Alloy—Steel and Steel Alloy
Heavy Iron Castings and Rolling Mill Equipment
AVONMORE, PA.

Keep Motors "On The Line" For Greater Production

There are no "spare" motors today. Burn out a motor and production is cut until it goes back in service. If it must be rewound you lose even more time. That's why you can't tolerate oils that leak or are thrown from bearings onto windings — to cause short circuits.

NON-FLUID OIL boosts production by keeping motors in operation through clean, dependable lubrication. It stays in bearings and off windings, even when exposed to heat and vibration. NON-FLUID OIL lasts longer than oil, needs less frequent application, so cuts lubrication cost.

Used successfully in leading iron and steel mills. Send for instructive bulletins.

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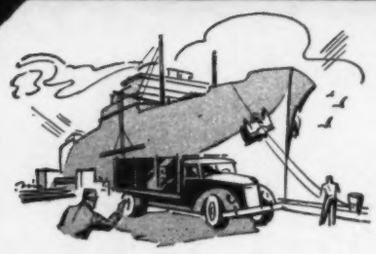
TRADE MARK REGISTERED
NON-FLUID OIL
IN U.S. PAT OFFICE & FOREIGN COUNTRIES

Modern Steel Mill Lubricant

Better Lubrication at Less Cost per Month

MORGANITE BRUSHES



Efficient brush operation is dependent upon the judgment used in the selection of grade and style.

D. C. designing engineers have had years of experience in choosing brush grades. When new problems arise, they usually consult a reputable brush engineer. At times, however, local condition or unusual use of a machine may adversely affect brush operation.

When brushes are not performing satisfactorily, call a Morganite brush engineer. He can often offer suggestions which will eliminate the trouble without changing the brushes.

Our desire is to satisfy you as a prospective customer, not to sell you brushes which you do not need.

MORGANITE BRUSH COMPANY, Inc.
Long Island City 1, New York

TRADE MARK

No. 6 In a Series of Factors Essential to Maximum Brush Efficiency

...care must be used in choosing the proper grade of brush

GREATLY REDUCES *Bearing Wear and Replacements* . . . yet it is as SIMPLE as ABC . . .

NO OBLIQUE RESULTANT
ALL RADIAL loads carried at RIGHT ANGLES to the roller axis
ALL THRUST loads carried at RIGHT ANGLES to the roller axis

A all radial loads carried at right angles to the roller axis

B all thrust loads carried at right angles to the roller axis

C no oblique components to complicate radial and thrust pressures.

with

ROLLWAY RIGHT-ANGLED LOADING

Costs pared to the bone! That will be the production slogan after the war. And right now — with new designs on your boards — is the time to think about new, longer-wearing or higher-capacity bearings . . . both for your production machinery, and for the products you make. Find out how Rollway's Right-Angled Bearing Loading will simplify the loads. How it will permit smaller housings, heavier pressures, or longer bearing life — even proportionate combinations of all three.

For compound loads, SEPARATE radial and thrust bearings are used in combination as per diagram.

Rollway Splits the Load, Reduces the Pressures

Because Rollway Roller Bearings are always loaded at right angles to the roller axis, only one load component—either pure radial or pure thrust—can bear upon the rollers. That means reduced load pressures within easily computed limits, greater resistance to shock, oscillating or vibrating loads, and to overloads. No oblique components can raise the stresses above the elastic limits. You know the simple forces you are dealing with, and you can provide for them adequately.

SAE and American Standard Metric Sizes

Rollway has developed many variations of its solid cylindrical roller bearings in SAE and American Standard metric sizes, each having definite characteristics to meet exacting needs.

Let us help you to take full advantage of this wide choice of types and sizes. Just send us your design, or a detailed description for free, confidential analysis. No obligation.

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BUILDING HEAVY-DUTY BEARINGS SINCE 1908 **BEARINGS**

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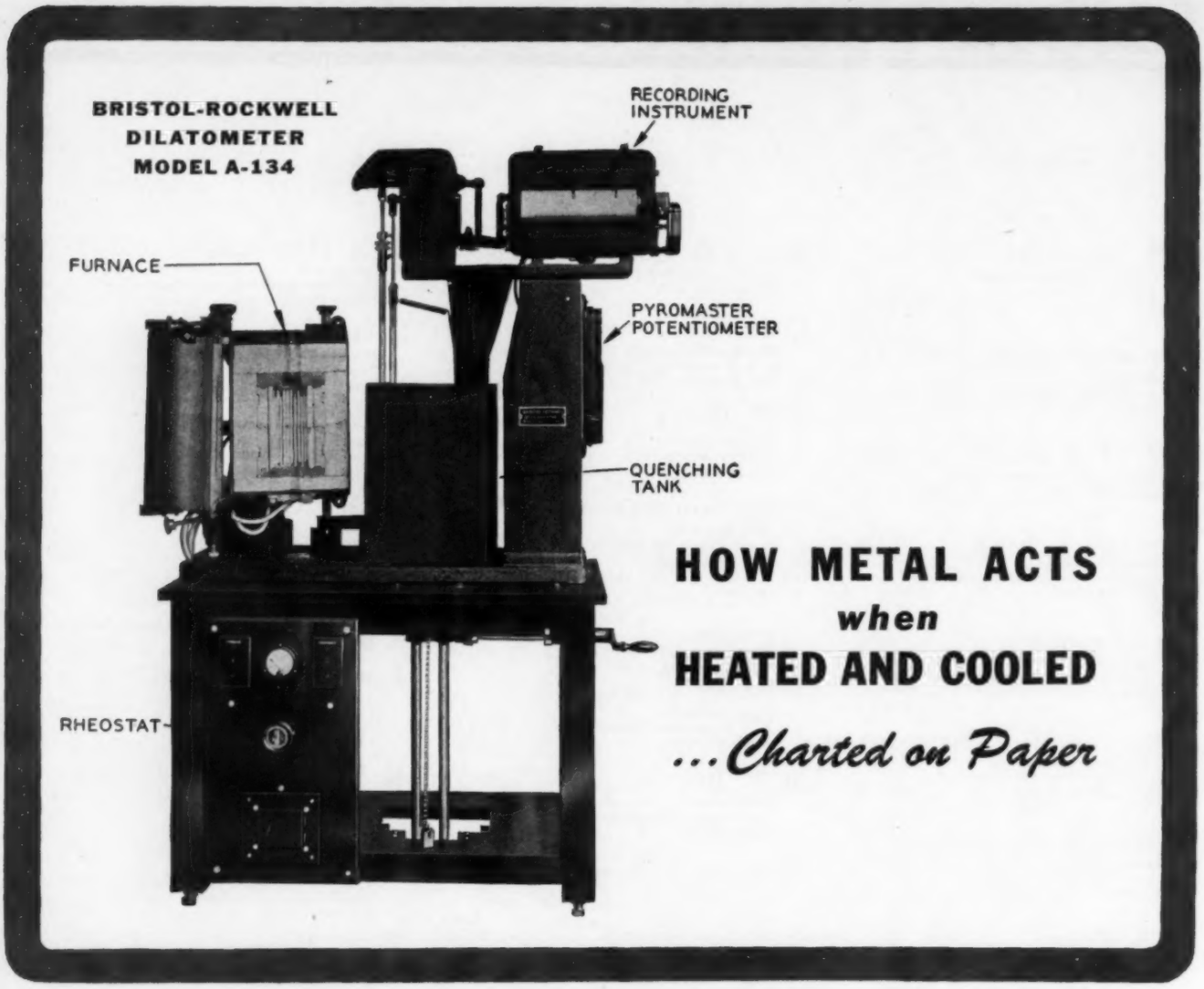

You can get four important types of information about temperature effects on metal—easily and accurately—from the improved model of the Bristol-Rockwell Dilatometer:

- **Critical points of carbon steel**
- **Coefficients of expansion**
- **Composition (from thermal curves)**
- **Heating rates and heat saturation**

Temperature-dilatation and temperature-time changes are recorded simultaneously during heating and cooling cycles.

The built-in electrical furnace (rheostat-controlled) heats to 2500°F. It takes samples up to 5" x 1⅝" (best sample size: 2¼" x 3¼" long). Ferrous and nonferrous metals can be tested.

Quenching Tank

An added feature is the quenching tank which can be raised to the quench position without moving the sample or interfering with the dilatation measuring system.

For full information send for Bulletin No. W1803

...Gives YOU the Most from Heat

AUTOMATIC CONTROLLING AND RECORDING INSTRUMENTS

The Bristol Co. of Canada, Ltd.
Toronto, Ontario

THE BRISTOL COMPANY, 123 Bristol Road
WATERBURY 91, CONN.

Bristol's Instrument Co., Ltd.
London, N.W. 10, England

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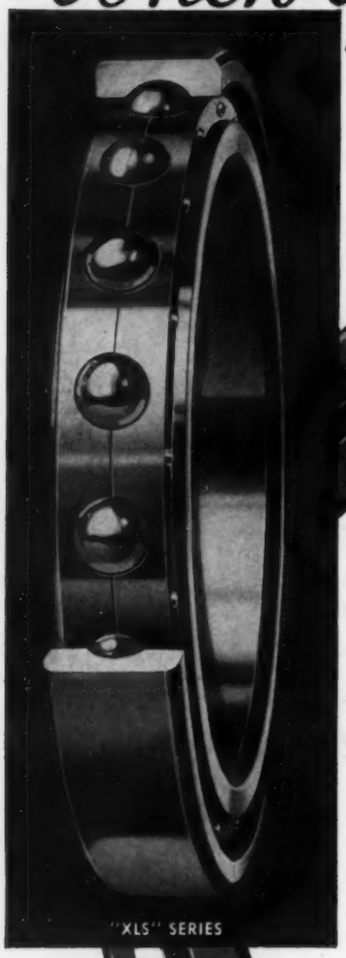
When You're Cramped for Space

USE THESE VERY LIGHT INCH SERIES BEARINGS

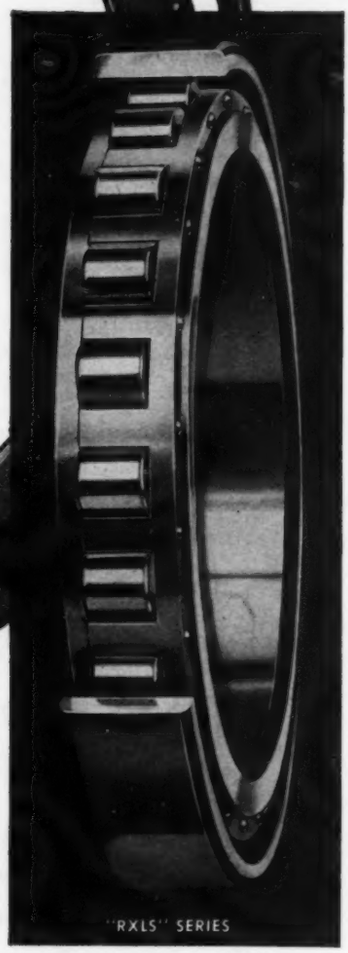


"XLS" SERIES

HAVING bores abnormally large, as compared with the outside diameter, they offer definite advantages under certain conditions found in machine design. You may have them in several different types, *affording compactness, light weight, and greater latitude in your design.*

There are several lines of very light type ball bearings, which include the "S" starting at 1/8" bore, and the "XLS" starting at 1 3/8" bore, running up to a maximum of 21" bore and 28" outside diameter. And in very light type roller bearings, there is the "RXLS" Series, paralleling the "XLS" in size range.

Why not let our engineers tell you more about these Very Light Precision Bearings? Write for the Catalog.



"RXLS" SERIES

"NORMA-HOFFMANN"

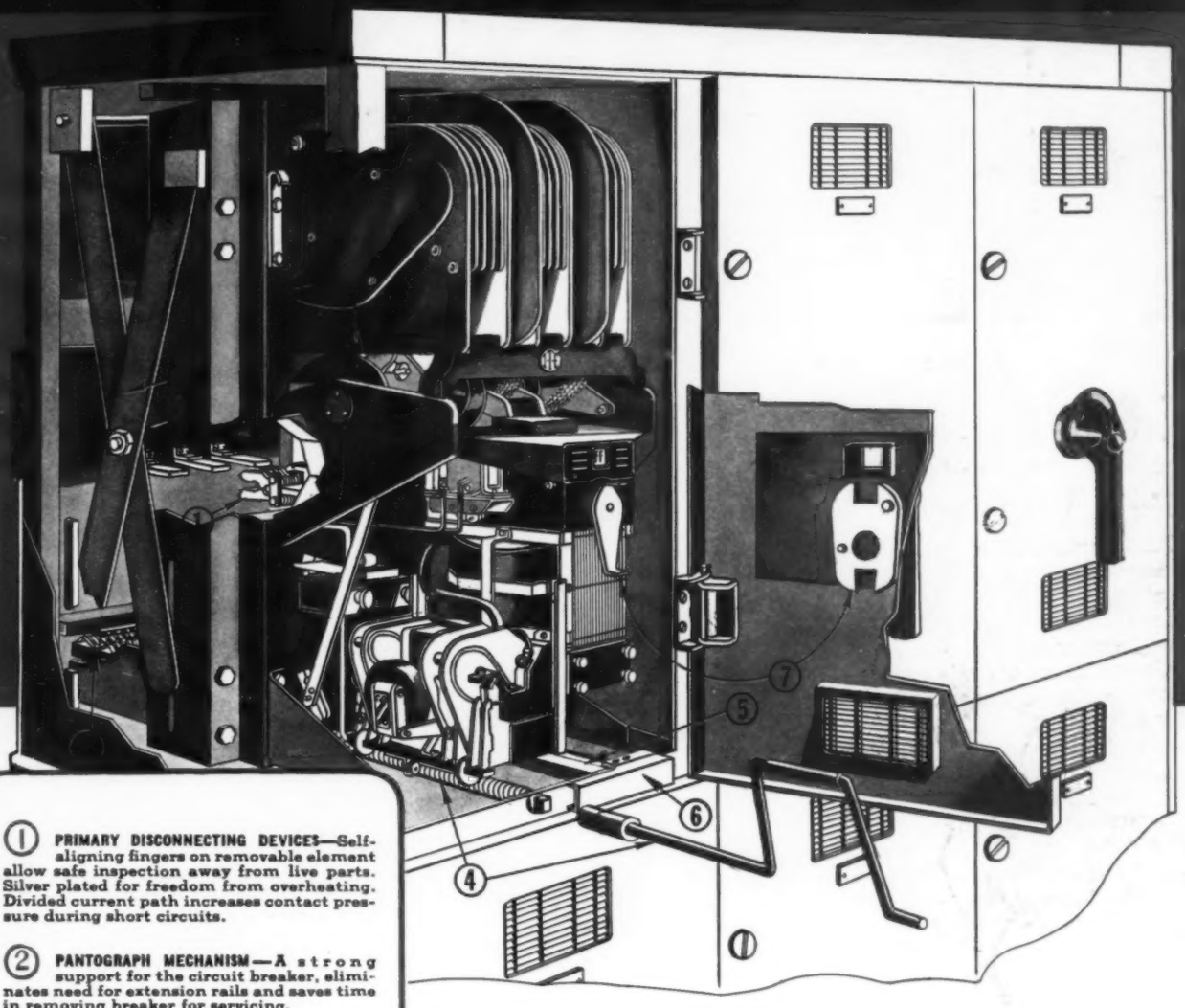
PRECISION BALL, ROLLER AND THRUST BEARINGS

To Win the War: — Work — Fight — Buy War Bonds

NORMA-HOFFMANN BEARINGS CORP'N. — STAMFORD, CONN., U. S. A.

Details of I-T-E Steel-Clad Switchgear

ARE WELL WORTH YOUR STUDY



① **PRIMARY DISCONNECTING DEVICES**—Self-aligning fingers on removable element allow safe inspection away from live parts. Silver plated for freedom from overheating. Divided current path increases contact pressure during short circuits.

② **PANTOGRAPH MECHANISM**—A strong support for the circuit breaker, eliminates need for extension rails and saves time in removing breaker for servicing.

③ **SECONDARY DISCONNECTING DEVICES**—For control relay, auxiliary switch and other small wiring circuits. Self-adjusting, silver plated. Flexible members mounted on removable element. Contacts closed at Test Position of breaker.

④ **DRAWOUT SCREW AND REMOVABLE CRANK**—Quick operating, triple-threaded screw allows fast drawout of breaker to Test or Removal Position. Crank has universal joint to allow operator to work comfortably.

⑤ **INTERLOCK TRIP SHAFT**—Provides safety for circuit and operator by actuating trip mechanism whenever the breaker is moved into or out of contact. Current cannot be broken on disconnecting devices.

⑥ **INTERLOCK SLIDE**—Connected to trip shaft, must be moved to expose end of drawout screw and allow removable crank to be attached. Crank cannot be in place with breaker closed.

⑦ **OPERATING MECHANISM**—Operating handle, furnished for both manually and electrically operated breakers, disconnects automatically from breaker when door is opened. Manual operation requires only a ninety degree turn of the handle.

To know the details of Multumite drawout switchgear is to have in mind a measure for determining what you will one day want to specify—a useful guide when the time comes for new installation of completely metal-enclosed switchgear structures.

The advantages noted above are but a few of many. For a thorough description, have us send you Bulletin 4207 which plainly identifies and illustrates the features incorporated by I-T-E for safety and convenience in control and distribution of electric power. Call your nearest I-T-E representative or write to I-T-E Circuit Breaker Company, 19th and Hamilton Streets, Philadelphia 30, Pa.

Representatives in Principal Cities

I-T-E

AIR SWITCHGEAR

Want 1/2 CYCLE SHORT-CIRCUIT PROTECTION FOR YOUR MOTORS?

USE G-E LIMITAMP CONTROL

Equipped with EJ-2 Fuses
Contactors Good for Years of Constant, Repetitive Service

THIS control gives your motor the fast, positive short-circuit protection so necessary for safe operation on high voltages. Its interrupting capacity is more than adequate for installation on most industrial power circuits, and it can be used with squirrel cage, synchronous, and wound-rotor motors.

The current-limiting fuses, Type EJ-2, are an especially important feature. They operate in a split-cycle. When a short occurs, they cut off the rise in current in less than a quarter cycle, and clear it in less than a half cycle—long before the short has had time to harm the contactor or motor.

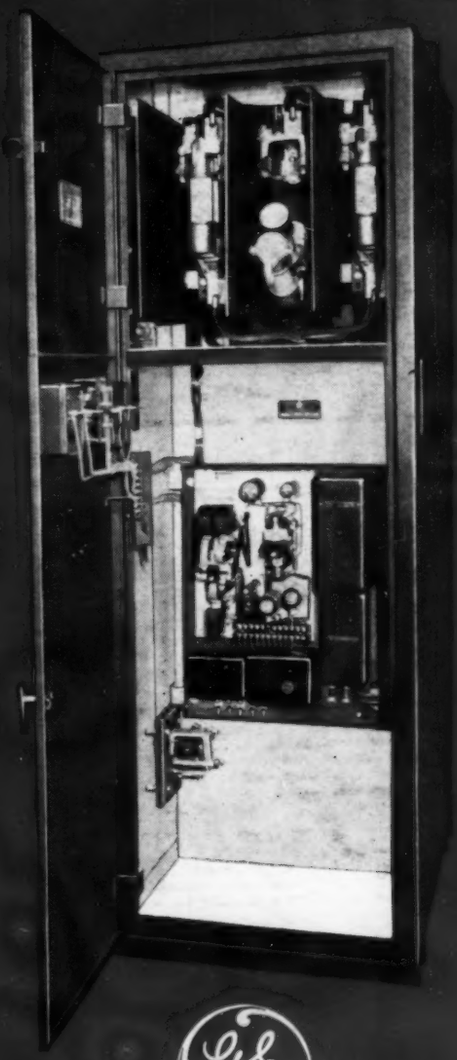
The full short never passes through the contactors in Limitamp controllers. Also, these contactors, which are air-break, are designed to meet the most severe requirements of high-voltage motor-control service. Mechanical life of several million operations, and contact-tip life twenty or more times the life of comparable oil-immersed tips, make these air-break contactors the logical answer for any severe duty—in steel mills, rubber mills, etc.

Here are 3 other important advantages

1. *Overload protection*—Isothermic overload relays protect the motor from overheating due to sustained overloads, locked rotor, or single-phasing.
2. *Personnel protection*—Totally metal-enclosed controllers give protection to operating personnel.
3. *Undervoltage protection*—All Limitamp controllers can be furnished with either instantaneous or time-delay undervoltage protection.

Need More Information?

You'll want to know all about this motor control. How the bus bars are enclosed for the operators' protection. How a group of these starters can be fitted together to give you a neat, compact control panel. Our local sales engineers will be glad to help you select a control to fit your application. *General Electric Company, Schenectady 5, N. Y.*



INDUSTRIAL CONTROL

GENERAL ELECTRIC

676-160-8900

Buy all the BONDS you can—and keep all you buy